REFINER
AND NATURAL GASOLINE MANUFACTURER

JANUARY, 1940
Vol. 19, No. 1

A Gulf Publishing Company Publication
EDITED MONTHLY AT HOUSTON, TEXAS

GRADY TRIPLETT
Editor

Copyright, 1940

CONTENTS

Refining Development—Review and Prospect 1
George F. Fitzgerald

Catalytic Possibilities Have West Coast Wondering 5

Equipment Inspection for Greater Refinery Safety 8
P. N. Gammelgard

Elements of Vaporization—The Phase Rule 16
R. L. Huntington

High Anti-Knock "Safety" Aviation Fuel 19
M. G. van Voohis

Application of X-Ray Inspection for Oil Refining Equipment .. 22
Herbert R. Isenberger

Pneumatic Jack for Removing and Replacing Exhaust Valve Cages 30

Departments

Look Box ..... 37 and 77

Record Demand for Oil Products Indicated for 1940 70
L. J. Logan

Plant Activities 88

Science and Technology (Abstracts) 93

New Equipment 102

Business Notes 110

Catalogs and Bulletins 112

Advertisers' Index 114

SPECIALIZED OIL JOURNALS

Published by

THE GULF PUBLISHING COMPANY

OFFICE OF PUBLICATION
3301 Buffalo Drive, Houston, Texas

R. L. DUDLEY, *President*
A. L. BURNS, *General Manager*
S. W. ROBINSON, *Editorial Director*
J. KENT RIDLEY, *Managing Editor*

NEW YORK: Room 625, 250 Park Avenue, Dick Swinsky, Manager.

PITTSBURGH: 72 Vandergrift Building, Chas. A. Wardley, Manager.

CHICAGO: 332 S. Michigan Avenue, H. G. Fitzpatrick, Manager.

LOS ANGELES: 425 W. W. Wilson Building, Huntington Park, California, Jay Curts, Jr., Manager.

TULSA: 1513 Hunt Building, J. F. Carter, Jr., Manager.

FT. WORTH: 203 W. T. Waggoner Building, H. H. King, Manager.

Single copies 20 cents. Special issues single copies 50 cents. Domestic subscription price $1.00 a year. Canada and Foreign subscription price $2.00 a year. Entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879. Advertising rates on application.

Copyrighted 1940 by The Gulf Publishing Company.

Note absence of by-passes around these Masoneilan control valves.

A LARGE western refinery paid a higher initial purchase price for these main line control valves than for any others they had previously bought — yet actually these valves cost them nothing, for they more than paid for themselves *before they were installed.* Why? Because the unique Masoneilan Manual Operating Unit avoided any need for by-passing these valves. Thus a huge expenditure for piping, fittings and welding, which would have amounted to far more than the cost of the valves, was eliminated. The valves actually combine automatic and manual operation, yet neither mode of operation interferes with the other. The safety factors usually supplied through by-passing are incorporated in the valve itself. The convenience of hand operation during warm up and the greater accuracy of manual control possible when instruments are not in use are valuable features; in addition the handwheel permits opening or closing the valve manually as much as desired in emergencies even when valve is on automatic control.

Indicating pointers provide magnified indication to enable the operator to read valve position accurately — and to gauge the setting of adjustable stops and handwheel so that the valve will travel only a predetermined amount through any desired portion of 100% valve travel when on automatic control.

We suggest that you inquire how these exclusive features can improve control and reduce costs in *your* plant. Describe your operating conditions to a Mason-Neilan engineer — or write us direct giving us complete data.

VOLUME 19, No. 1 JANUARY, 1940

REFINER
AND NATURAL GASOLINE MANUFACTURER
A GULF PUBLISHING COMPANY PUBLICATION

The Look Box

FOR its welfare in 1940 the refining industry must look to the home market. This conclusion comes from reading statements of several executives, quoted elsewhere in this issue. They are convinced that the financial ability of the American people to buy and use automobiles will be the source of any profit the industry gains.

Home, Peace And Profit

As a user of gasoline the European war has been a disappointment. Students of foreign affairs predict no change in 1940. Evidently consumption of petroleum products in military circles has been discounted by restrictions in domestic use. The Central countries have been closed by the sea blockade. In addition the Allied powers have oil sources in South America and Asia.

Evidently the estimates of 5 percent increase in consumption of refined products for 1940 are based on the home market.

This prospect raises the question of what is to be done with the improved motor fuels which must come out of the new refining process now in use and building. Statisticians can prove that there is no need for all the 100-octane gasoline that will be available in 1940, that in 1941 its amount will be further out of line with demand.

It is neither proper nor possible for the statistician to anticipate influence of research. Fortunately the answer will come from the research laboratory. Again the petroleum industry must get its market from what the builder of a motor accomplishes.

The automobile industry is turning attention to the possibilities of 100-octane fuel. Adoption of these motors to passenger cars is not anticipated for 1940, perhaps not during 1941. Still there is every reason to expect the ordinary passenger automobile to come up with an engine which can get the value out of these gasolines. Already the airplane engine is doing it but the use is restricted to trans-oceanic flying and military uses. Still this industry anticipates the day when its airplanes will span the United States in 6 hours, an accomplishment that will require equipment not yet built and gasoline not yet made.

Less spectacular but more valuable is the growth of oil as a home-heating fuel. Distillates and heavy fuel oils showed the highest consumption gains in 1940. Producers of other fuels complain of this as a waste on the basis that oil is supplanting cheaper fuels. Whatever the merits

of this contention, there is no denying that oil is gaining as a home heating fuel because of its cleanliness and convenience.

Only by looking far ahead can substantial consumption of oil as a substitute for coal in chemistry be considered. The research laboratory has accomplished isolation of hydrocarbons from which competitors for the coal-tar derivatives can be made. Not enough manufacturing of these will be done this year or next to make a dent in total consumption. What this accomplishment does promise is that as the chemist provides a motor fuel capable of driving an automobile more miles per gallon, he is learning now to push other parts of crude oil into other avenues.

Refining is a romantic industry, still it must look to the family automobile, the family fireside, the factory boiler and the factory bearing for its current profits. These peaceful pursuits may not reveal sharp peaks in demand as war will but they are of longer duration and more reliable.

Oil Reserve Doubled

IF IT were possible to express the reserves of crude oil in energy rather than barrels, the potential power at hand would be staggering. Reserves are so many billion barrels of oil, now around 15,000,000,000. But the horsepower in a barrel of crude oil of 15 years ago and the horsepower in a similar barrel of oil today are different figures.

Once the energy in a barrel of oil was the amount of gasoline from skimming, next it became the energy available through cracking, now it is the energy of these plus chemical synthesis. This means more energy from crude oil, says Frank A. Howard, who is quoted at length elsewhere:

"Perhaps an insight into the significance of these technological advances would be worth while. I think they indicate the possibility of an automobile engine half the size of the present engine with some increase in power and with mileage per gallon twice the present average."

Evidently it is time for the engine designer to catch up with the gasoline designer. The gasoline maker has learned how to combine some hydrocarbons to the end that 100 octane gasoline is a commercial product. With automobile engines capable of taking advantage of this fuel, the reserve of crude oil in terms of energy moves into higher totals.

United Front

UNANIMOUS opposition to federal control has marked all hearings on the Cole bill. State conservation officials were giving their opinions in New Orleans in December when hearings were halted because of the death of Carl Edgar Mapes, Congressman from Michigan, a member of the subcommittee.

The producing division of the petroleum industry has voiced its opposition by numerous resolutions as well as by appearance of men before the committee. Enough of this has come about to warrant the conclusion that control by any federal agency will come about only by overcoming stout defense.

It must not be assumed, however, that this defense will not be met with stout offense. Harold L. Ickes, Secretary of the Interior, has left no doubt of his attitude. The effort to place federal supervision over state supervision is a fetish with this battling cabinet member.

In the Name of Accuracy

WHEN the bristling Secretary of the Interior was having his tilt with the press, he called for a censorship in the name of accuracy. His opponents at that time were the columnists.

A supposition of that day was that since Harold L. Ickes wanted fair play he would grant fair play. But imagine the following exerpt from a radio script of Department of Interior approval, in the name of accuracy, fair play or honesty:

Host: "How do you like these oil wells in Texas, in Arkansas, in California?"

Visitor: "Wonderful supply."

Host: "Yes, they look very nice when they all shoot up in the air at once, like this—"

Sound: Gushing of many oil wells.

Visitor: (Aghast) "Stop it! You're wasting all the oil in—"

Host: "Makes a pretty sound. Brings in the money."

Visitor: "But those wells can't be used again. There is no need for such negligence and waste."

Host: "Really, you mustn't interfere. We can do what we like with our natural resources. This is a democracy, isn't it?"

Propaganda of that stripe is convincing, convincing in the proposition that someone wants federal control of the oil industry and wants it regardless of honesty.

Refinery Developments ... Review *and* Prospect

GEORGE F. FITZGERALD

PETROLEUM processing is characterized by constant change. The trend started several years ago with the introduction of solvent methods but very few realized then how far this would be carried. Each year new processes for gasoline or motor-oil manufacture are put into commercial use while still others are advancing through laboratory stages to pilot-plant and semi-commercial operation. Refiners are now familiar with chemical processes that had not been even experimentally applied to petroleum a few years ago.

Much of this progress is owed to research scientists who have investigated the nature and composition of the hydrocarbons found in motor fuels and lubricating oils. Their work has revealed which are the harmful and which the valuable components in lubricants, thus pointing the way to solvent-extraction methods. The demonstration of the relation between chemical structure and anti-knock value in gasoline has advanced not only the art of cracking but has given the industry such new tools as polymerization, cyclization, isomerization, and alkylation.

That even technological advances will be made is assured by the growing popularity of the new refining methods and the ever-increasing demand for high-quality petroleum products. The demand in the last six months of 1939 exceeded all previous records for distillates and gas oils. Sales of oil burners, the index of new business for burning oils, enjoy a steady increase. Important, likewise, to the oil industry is the general industrial pick-up, particularly the automotive where car and truck sales are at least 50 percent better than in 1938. Increased factory output has provided a strong demand for heavy fuel oils which for months had been a drug on the market.

Diesel fuels are likewise enjoying an active sale. The railroads began increasing their consumption in 1936 and by early 1939 close to 85 percent of the new locomotives delivered were Diesel-electrics. In this field Diesels are said to average $1.85 per hour superior economy.

CONSTRUCTION

Increasing demands and general business improvement usually result in active building programs in the oil industry. The past year has been no exception. The exact status of new construction abroad has been problematical since war broke out. A general "blackout" of all information regarding location, capacity and types of new units has been instituted. American engineering firms engaged on foreign projects are respecting this policy but data relative to work started prior to September, 1939, are available. The value of new foreign construction is said to be in the neighborhood of $100,000,000. Some of the items are a large catalytic cracking unit and two alkylation plants in France, a complete refinery at the Haifa terminus of the Iraq pipe line, and a catalytic reforming unit and alkylation plant at Abadan, Iran, on the Persian Gulf. Two refineries in Great Britain also have alkylation and catalytic reforming units under way and the Manchester refinery has a new unit for the complete processing of transformer oils and white oils. At the Grozny refinery the Soviets are making scheduled progress on an expansion program which includes a dewaxing plant, a solvent extraction unit, and a selective polymerization plant.

South American refineries are answering the call for increased facilities. At Aruba and Curacao two of the largest refineries in the world are adopting alkylation, polymerization and gas recovery. Curacao is also expanding to handle a new supply of crude. These new units will furnish sorely needed high-octane blending stocks for the gasoline regularly made from Venezuelan crude. Standard Oil Company of Venezuela is building a complete refinery of 27,000 barrels per day capacity and 20,000 barrels per day cracking capacity.

Domestic sales of refinery equipment are on the increase. They indicate a speed-up of refinery construction as many orders have been released ahead of schedule. There is evident a desire to anticipate expected rises in labor costs and steel prices. One of the largest single contract projects in the industry is the $5,000,000 Richfield Oil Company refinery at Watson, California. It consists of a double combination unit with topping and cracking capacity of 50,000 barrels per day. Supplementary equipment for debutanizing, depropanizing, stabilizing, hydrogen sulfide scrubbing, and catalytic polymerizing are included. An interesting feature of the construction is that most of the equipment and the piping subassemblies were shop-fabricated. An unusual amount of chrome-alloy was used for linings in the cracking systems and condensers. In keeping with current trends the refinery operations are controlled by the

most modern available instruments for regulating liquid levels, temperatures and pressures, and flow conditions.

IN NEW OIL FIELDS

An impetus to further expansion and modernization in the Mid-West has been occasioned by the rapid rise to importance of the Illinois field. Most of the plants already in operation in this area have been enlarged and modernized to handle the new supply of crude. Yazoo Refining Company is building a skimming plant and a $200,000 cracking unit in Mississippi which is now practically finished. This unit has a daily capacity of 2,000 barrels and the production of fuel oils will be a specialty. A dozen or so other new skimming plants were also erected in 1939. These were combined in a few cases with cracking facilities but are temporary in nature.

Refineries in the St. Louis area now take large deliveries of Illinois crude in place of Oklahoma and Kansas oil. Shell Oil Company is spending $8,000,000 to expand its Wood River, Illinois, plant. Crude capacity will be increased from 50,000 to 75,000 barrels per day by the installation of a topping plant. A new crude still is also planned for the future. Other new units included a compounding house, catalytic polymerization and alkylation, high-pressure boilers, and a cracking unit. This unit will crack heavy oils to high-octane stock at the rate of 18,000 barrels per day. With completion of this work the Shell Oil Company plant at East Chicago is to be shut down and the Wood River-Chicago crude pipe line converted to gasoline service. Socony-Vacuum Oil Company refinery at Trenton, Michigan, is also enlarging and is now processing Illinois crude delivered through its own line via Lima, Ohio.

ALKYLATION PROGRESS

Refineries in other parts of this country and Canada are recognizing the need for modernization and enlargement. Continental Oil Company is spending $1,250,000 for a thermal cracking unit at Ponca City. An additional $250,000 will go to remodeling the steam system, new pumping facilities and electrical equipment. The complete modernization of the Baton Rouge plant of the Standard Oil Company of Louisiana will cost $3,000,000 making a total capital outlay of $15,000,000 in the last five years. Many other Gulf Coast refineries are installing complete new units and making additions to present equipment. In some cases plants that did no building in 1939 are planning new projects. It is expected that building during 1940 will equal or exceed any previous year.

The increasing demand for aviation-grade and super-premium gasolines has caused a rush for alkylation plants. There are now six in this area under construction or completed and another is being planned. Included in this list are the $1,000,000 plant at the Shell Oil Company refinery at Houston and Magnolia Petroleum Company's unit now more than half completed at Beaumont. The latter will have a capacity of approximately 2500 barrels of alkylate per day or about 1,000,000 barrels per year of finished aviation fuel. The second Houdry unit is now in operation at Beaumont. The two units have a combined capacity of 30,000 barrels of crude per day.

The eastern states are likewise enjoying a building boom with six Houdry crackers under construction or completed at an average cost of $3,000,000. Sinclair Refining Company has recently put into operation a benzol-ketone dewaxing plant of the latest design at Wellsville, New York. Midget polymerization plants are represented by one at Quaker State Oil Refining Company's Smethport plant and another near Oil City for the benefit of several independent refiners.

In Canada a $250,000 cracking plant is going up at Regina for Consumers' Cooperative and at East Calgary Imperial Oil Company is putting a new cracking unit into operation. Turner Valley crude will be processed to make aviation-grade gasoline. Imperial Oil Company's complete expansion program will run close to $2,000,000 and will increase plant capacity to 9500 barrels. A polymerization plant to make 100-octane gasoline from Turner Valley gas is being considered by Gas & Oil Products, Ltd., in South Turner Valley.

CRACKING

As in previous years, the art of cracking demands a major share of attention in any discussion of refinery progress. A year ago the industry received the long-awaited official announcement of the Houdry catalytic process. Today complete details of a 138-day commercial run of the first Magnolia unit at Beaumont have been reported. The data given include complete yields, temperatures, pressures, rates of flow, kinds of equipment, and utilities. The unit was built to produce No. 2 fuel as a main product with high-octane gasoline secondary. This necessity results from an active demand for light fuel while the old thermal crackers produced an excess of heavy fuel. Practically all the major equipment—towers, exchangers, catalyst cases, piping, and pumps are of ordinary steel construction and very little expensive high-alloy steel is used. This remark applies equally to the oil, salt, water, steam and air systems. The lower temperatures and pressures required in catalytic cracking are in contrast to the increasingly severe conditions current in thermal cracking.

The Houdry unit now under construction at the Lubrite Division, Socony-Vacuum Oil Company in East St. Louis furnishes an example of the adaptability of the new cracking process to the needs of individual plants. The basic Socony-Vacuum design has been modified slightly to yield the best results on Illinois crude. With a through-put of 16,000 barrels per day the unit will produce straight run gasoline and kerosene by topping, and high-octane gasoline blending stock and No. 2 and 3 fuels by catalysis. There will also be a nominal amount of heavy fuel and gas. The installation includes 6 catalyst cases; 2 to be on stream, 2 on regeneration, and 2 off regeneration. The excess heat of regeneration is recovered by driving a heat turbine with the flue gases. Power so developed operates the compressor which blows the catalyst cases on regeneration. Any excess power is used to operate an electric generator. Circulating salt solution, a Houdry innovation, is used for temperature control. Motor-operated cycle timers automatically change over from spent catalyst cases to fresh and regenerate the spent cases. This catalytic cracking unit is designed so that the average man in the refinery can be readily trained as an operator. In the event of minor disturbances the charge vapors may be recirculated and the catalyst cases bypassed without loss of operating temperature. Installation costs are about double that of a thermal unit of the same

capacity but official figures place the payout time at about three years.

The importance of keeping pace with technological developments in gasoline manufacture is indicated by the building program now in progress. Already catalytically refined gasoline is available. That the cracking process is not all-sufficient is evident by the many new complementary processes now attaining commercial success. These methods discussed at great length at the last annual American Petroleum Institute meeting.

Polymerization and rerun units. Polymerization furnace at right, catalytic columns at right center, with rerun furnace and fractionation column at left.

Alkylation, or the combining of iso-paraffins with olefins to form high-octane fuels, now accounts for a large proportion of the 100-octane gasoline on the market. While this product is at present purely an aircraft fuel, development in its production cannot fail to aid manufacturers of automotive gasoline. It is only necessary to recall that 67-octane was acceptable airplane fuel a dozen years ago to realize that equally great strides may be made in the next decade.

Present national capacity for 100-octane fuel is approximately 270,000,000 gallons per year. At the recent meeting of the Society of Automotive Engineers it was pointed out that there is reason to expect a need for higher octane fuel for the projected airplane engines of abnormally high compression. New construction and projected installations will increase output to about 330,000,000 gallons by the end of 1940. In some quarters this rapid increase is looked upon as over-expansion because the trend is leading to an estimated production of 400,000,000 gallons per year early in 1941. That figure is almost four times the quantity of all grades of aviation fuel actually consumed in this country in 1938. It seems certain that if 100-octane is produced in excess over aviation demands it will be diverted into super-premium motor gasoline. What that would mean to the well-known "octane race" is obvious. Even third-grade gasoline has joined this race with a jump of about ten numbers from 1938 to 1939. Other indications too important to overlook are the fact that 80 percent of new tractors now require at least 70-octane fuel and that two automobile makers are road-testing experimental cars which require 100-octane fuel.

One of the latest new methods for producing high-octane gasoline is the neo-hexane process announced by Phillips Petroleum Company. This is a thermal alkylation operation reacting ethylene and isobutane. the neo-hexane so formed is a stable, saturated paraffin hydrocarbon testing approximately 100-octane number. Lead susceptibility is high and at a TEL concentration of 3 cc. is equal to pure iso-octane containing 3 cc. TEL. The first commercial plant should be in operation this month. The necessary ethylene will be obtained by low-pressure cracking of an ethane-propane mixture.

Both thermal and catalytic alkylation of olefin-paraffin mixtures are well advanced commercially. There are six or seven plants in actual operation with 12 or 15 more under construction. They range in capacity from 100 to 2000 barrels per day of alkylate. The average size is about 500 barrels and is governed by the available supply of isobutane. To bring about this combination of isobutane and butylene 98 percent sulfuric acid is consumed at the rate of ½ to ¾ pound per gallon of alkylate. The question of handling this spent acid must be solved by

each refiner. Where acid restoration facilities are available the matter is simple. In other cases some solution such as resale to the supplier must be negotiated. Technically the process has long been known as applied to aromatics but had not been tried with paraffins until about seven years ago. It may be considered as a special case of polymerization with the great advantage that yields are almost double. Each refinery setup must be studied individually and it cannot be assumed that alkylation will displace existing polymerization plants or even be preferrable where either might be installed. Catalytic alkylation by means of cold sulfuric acid, for example, would hold the advantage at refineries having their own acid concentrating plants. Also catalytic alkylation produces 100-octane blending stock in one operation in contrast to polymerization + hydrogenation or ethane-propane cracking + thermal alkylation. Supplies of the right hydrocarbons, the economics involved, and other considerations must be determined before proper choice can be made.

FOR SMALL PLANTS

Systems employing thermal cracking combined with polymerization of the cracked gases are being offered competition by the naphtha Polyform process. It handles a charge made up of a 250-450-end point naphtha which is mixed with propanes and butanes from stabilizers or other cracking units and then reacted thermally. Advantage is claimed because a single plant yields in one operation a product of 70-78-octane number. Catalytic reforming and dehydrogenation methods are likewise being improved and their number increased. Catalytic dehydrogenation of straight-run gasoline raises the octane number 15-20 points, depending on the charge stock. A cheap bauxite catalyst is used which gives yields of about 500 barrels per day per ton with an average cycle time of 30 hours. A desirable feature for plants handling sour distillates is the fact that sulfur is removed in the process. Catalytic dehydrogenation is already commercially successful and it is expected because of its adaptability to small units to be very attractive to small refineries. Construction costs are estimated at $165,000 for a 1000-barrel plant. Most of the other catalytic operations, except cracking, are available in large or small units. This is an advantage for the smaller refiner who sees catalytic cracking apparently restricted to units of 5000 barrels or over. It is understood, however, that two small Houdry units are under construction in France. For the present, then, the small-scale refiners will be concentrating their study on such processes as catalytic polymerization, reforming, dehydrogenation, and alkylation. This is especially true for the many independent Pennsylvania operators. Their crude is famous primarily for lubes and their gasoline production represents only about two percent of the national total, nevertheless that two percent accounts for roughly 50 percent of their crude consumption.

It requires no gift of prophecy to realize that catalytic methods hold the key to progress in the next decade. From the basis of our present successful beginnings these methods will be made more selective and more efficient. The natural catalysts such as processed clays and bauxite are rivalled by synthetics like nickel, tungsten and vanadium oxides. The natural materials are generally preferred for their lower first cost, ruggedness, and simplicity of regeneration.

DESULFURIZING

As indicated earlier, sulfur removal is often accomplished incidentally in the production of high-octane stocks. Many plants, however, require separate installations for the sweetening of straight-run and cracked distillates. The copper treating methods brought out in the past few years are gaining ground in this field. Early this year a 1000-barrel-per-day unit will be in operation in Charleston, West Virginia. This type was chosen because comparative pilot plant tests gave it the best rating on the basis of lead-susceptibility of the sweetened product. Gas & Oil Products, Ltd., has lately installed a 1200-barrel liquid-copper-sweetening unit to process both straight-run and cracked products from Calgary crude. A similar unit for Standard Oil Company of Ohio is building at Latonia, Kentucky, to handle stabilizer bottoms. At Cut Bank, Montana, Glacier Production Company has a 2000-barrel unit under construction and at least two others are building elsewhere.

Other new methods for sulfur removal are the catalytic such as Houdry, the Stratcold acid-treating, and the extraction process of Shell Development Company. The first two are in commercial operation and the third has reached the commercial stage. Houdry treating units are being installed in connection with at least 6 of the 12 crackers now building. A $500,000 cold-acid-treating plant was completed last year for Richfield Oil Company at its Watson, California, plant. It is of the three-stage settler type treating debutanized cracked distillate. Any reasonable reduction of sulfur content may be obtained by varying the conditions. The plant is featured by all-electric drive.

LUBRICANT MANUFACTURE

The gasoline situation during the past year has attracted so much attention that lubricants have been given relatively little space. Actually, however, the advances in manufacturing methods made in the past five years are being consolidated and capacities have been expanded in keeping with the current trend. Solvent dewaxing and extracting plants built today have full benefit of experience carefully gathered from previous installations. The latest solvent dewaxing plant built in the Pennsylvania area is that of Sinclair Refining Company at Wellsville, New York. It employs the conventional benzol-ketone solvent but significant changes have been made in operation. Direct-fired heaters and high-pressure towers followed by low-pressure towers are used for final stripping of solvent from dewaxed oil and wax. Wax cake may be "re-pulped" with solvent and charged to secondary filters to yield drier wax or higher melting point petrolatum. Anhydrous ammonia is produced from a bubble tower instead of a generator.

In the extraction field the order of installed capacity remains about the same: Furfural, Duo-Sol, Phenol, Benzol-SO_2 and Chlorex. Because of the resultant improved engine performance the majority of leading brand oils are solvent treated. Phenol is giving Chlorex competition with a new unit under construction in Pennsylvania.

Percolation filtering is receiving more and more study since the introduction of bauxite. This material is now in use by over a score of refiners in the East-

(Continued on page 45)

Catalytic Possibilities

Have West Coast Wondering

VIEWED in retrospect, 1939 has been one of the most interesting years in the history of the Pacific Coast's refining industry, partly because of several interesting plant developments and partly because of efforts to appraise catalytic cracking and alkylation and assign these important developments a place in the economic pattern of the West's oil structure.

So far, catalytic cracking is still in the appraisal stage, although Standard Oil Company of California (and probably others) is licensed under the Houdry patents, the atmosphere is still laden with technical questions which must be answered before ground is broken for any kind of an installation. Reports indicate that the research laboratories are trying out selected crudes to determine the most effective charging stocks and the effect of different impurities on catalyst performance and life.

Catalytic cracking—and recently alkylation, have had a disturbing effect in California because as late as 1932 it appeared to many that the next few years would witness a slowing down of process developments of any magnitude to the steady pace of consolidating what was known of existing processes, and their ultimate perfection. Such assumptions however failed to reckon that unprecedented advancements in the automotive and aeronautic industries would create a demand which could be satisfied only by revolutionary departures in refining technology.

For years refinery chemists have been studying mysterious substances called catalysts which were known to possess the ability of causing chemical reactions to take place without taking part in these reactions themselves. Experiments were made with the purpose of using these substances to prod sluggish, unreactive petroleum hydrocarbons into combining with others in different ways to yield products of commercial value.

ALL IN FIVE YEARS

Among the first indications of the potential magic of catalysis was the news, less than five years ago, that waste refinery gases could be treated in a manner which would cause them to polymerize to liquids of high anti-knock value. While known to scientists for many years previous, and suspected by refinery engineers as among the reactions taking place during cracking, yet the ability to control polymerization with a selected raw material made it apparent that the curtain was finally rising on a stage full of wonders. From refinery to refinery went the word that what the vegetable oil and many other industries had been doing with catalysts for many years was now becoming possible to the petroleum industry.

The immediate and rapid development of both catalytic and thermal polymerization took place in an orderly manner and further significance to the trend came when, in 1937, a process was described for polymerizing selected refinery gases with cold and hot sulphuric acid to yield iso-octene and interpolymers. Last year another contribution to the new refining technology came when Eugene Houdry described his process. And less than a month ago came the disclosure of a process whereby iso-butane, a hydrocarbon found in natural gas, can be "alkylated" by the iso-butylene in a refinery gas to form iso-octane.

One reliable source points out that any consideration given catalytic cracking by California refiners must take into consideration that: installation costs are probably higher than for conventional cracking; and operating costs are likely to be higher because of catalyst regeneration, replacement and licensing costs. Moreover, an analysis of yields would indicate that they are not higher than those obtained by efficient thermal cracking, but that the yield per pass is much higher. And further, that the gasoline produced by catalytic cracking is of higher quality, with a high-grade gas oil as residuum instead of heavy fuel or cycle stocks.

Another view is that apparently catalytic cracking is being licensed on a paid-up basis, and that on a 10-year pay-off the cost would come close to 10 cents per barrel of stock charged to the catalyst. The catalyst also must be renewed from time to time and this cost amounts to about three quarters of a cent per barrel charge to the catalyst.

While it is felt in many quarters that catalytic cracking will take hold very slowly in California, with probably no major move during 1940, careful attention is being given to its potential possibilities. The Pacific Coast is bogged down with large volumes of heavy residual stocks, the conversion of which into a satisfactory gasoline would be of definite value. But any great interest in such a utilization must still be tempered by more effective curtailment measures in oil production. Many refiners would like to crack deeper, but are compelled to run crude arising either out of over-production or fixed contractual require-

ments. Any process which can convert high-sulphur crudes, such as those from Del Rey, Huntington Beach and Santa Maria, into good gasoline and gas oil is of genuine Coastal importance, and the fact that catalytic cracking emphasizes this possibility is a good reason for its eventual introduction in the West.

ALKYLATION

The disclosure of the sulphuric-acid alkylation of iso-butane and iso-butylene to form iso-octane at the last meeting of the American Petroleum Institute has served to broaden the field of high-octane blending agents and the West is giving its share of attention to the possibilites. The manufacture of iso-octane *per se* is not new to California, Shell Oil Company having made it by the acid method of polymerizing iso-butylene for the past four years. Standard Oil Company of California has also made iso-octane by the hydrogenation of selected polymers via catalytic polymerization.

However, the fact that sulphuric-acid alkylation utilizes iso-butane to almost double the yield, and eliminates the necessity for subsequent hydrogenation, has served to stimulate an active appraisal of its possibilities. In much the same manner as polymerization was first received, opinions are conflicting and greater in number than the sticks on a picket fence.

One trend of thought is that alkylation for a long time to come, as far as Califorina is concerned, will be limited to the production of iso-octane for aviation fuel manufacture. The process is visualized by many to be self-limiting in that the high investment cost of between $1000 and $2500 per barrel of alkylate renders the resulting product too costly for motor fuel manufacture. On the other hand, some argue that the savings in lead will pay for an alkylation unit if the volume of leaded gasoline produced is large.

HANDICAPS

On the whole, the reaction at the present writing appears to be that alkylation is for aviation gasoline what polymerization is to motor fuel, and that the market for premium fuels is still too narrow in the West to justify the conclusion that alkylation will take hold fast. Some of the arguments against the spread of the use of alkylate to raise the octane rating of motor fuels is that present fuels amply meet Pacific Coast driving requirements. The point is added that if any improvement in motor fuel is necessary that it should be in the direction of improving the distillation curve by lowering the 50 percent point and raising the 10 percent point.

Natural gasoline men can point to problems in the acquisition of a sustained supply of iso-butane for alkylation. Estimates of potential supplies of various hydrocarbons in large numbers of barrels is an impressive procedure, but visionary. Natural gasoline plants are not connected with pipe lines for shipping liquefied gas, and any trucking of iso-butane to a refinery will greatly raise the cost of the charging stock. Some California refiners have been canvassing the liquefied petroleum gas market for a sustained supply of iso-butane and have discovered to their surprise that it is nowhere near as available as originally thought, partly because the liquefied gas industry is not wholly in a position to prepare a close cut, and further, that the volume of iso-butane available falls short of estimates based on the potential amount.

One reliable source has summarized the present status of the alkylation question by observing that: (1) the process is of great value to the manufacture of aviation gasoline; (2) the existing market will handle only about one fifth of the potential volume which could be manufactured; (3) the high cost of producing alkylate will keep it out of the motor fuel field; and (4) an alkylation plant is costly in terms of barrels of product.

Among the Pacific Coast refiners active in the premium aviation fuel field are Shell Oil Company, Union Oil Company and Standard Oil Company of California. Shell Oil Company has just completed a 1500-barrel alkylation plant at its Dominguez refinery near Long Beach and probably will construct another at Martinez. A recent announcement by the Union Oil Company discloses that construction has begun on a $1,000,000 alkylation plant at its Wilmington refinery. An announcement by Standard Oil Company of California is expected before long.

CONSTRUCTION

The most recent refinery construction job to attract attention in California is that of the installation of a 1100-barrel, single-coil Dubbs unit and non-selective polymerizer for Fletcher Oil Company at Wilmington. Emphasizing the trend in the erection of small efficient refining units, this plant is a model of simplicity and efficiency. Designed to crack gas oil, kerosene distillate or fuel oil obtained contractually, the products consist of a 72-73-octane cracked gasoline and cracked fuel oil of low gravity, viscosity and cold test.

Essentially the cracking system consists of an upshot furnace, reaction chamber, fractionating column, stabilizer and vapor-recovery facilities. The furnace utilizes chromium-molybdenum headers and silicon alloy seamless steel tubes. The burners operate on either fuel oil, natural gas, or residue gases from the polymerizer.

A compressor feeds the gas to the polymerization unit by way of a preheater which raises the temperature to 325°-425°F. From the heater the gas passes to the two catalyst towers arranged in series. The towers are 2 feet in diameter and 14 feet 6 inches long, and are filled with solid phosphoric acid catalyst. The design is for working conditions of 500 pounds and 500°F. The polymers, along with unreacted gases are fed to the polymer plant stabilizer.

ACID-TREATING

The cold-acid treatment of gasoline by countercurrent washing with sulphuric acid came to the front this year when The Texas Company and Richfield Oil Company installed this system in their California refineries. In the main the process consists of bringing chilled raw distillate into contact with chilled acid countercurrently. This is done so that the untreated distillate first meets partly spent acid in the first and second stages of the cycle and finally fresh acid at the last stage. In each stage, after contacting cold distillate and acid, the sludge formed is

removed either by a centrifuge or settling tank. After the last stage of acid treatment the distillate is given a water-wash and then neutralized with soda before being sent to storage. The system of cold-treating is said to be advantageous in that acid consumption is low and octane-degredation low.

In The Texas Company's installation settling tanks are employed instead of centrifuges and the plant has a capacity for treating close to 6000 barrels of cracked naphtha distillate daily with 98 percent black acid in the ratio of 14 pounds of acid per barrel of distillate.

The Richfield Oil Company installation also utilizes settling tanks instead of centrifuges and operates at the capacity of 11,000 barrels a day with a ratio of 9 pounds of 98 percent acid per barrel. The first and second contact stages are carried out at 30°F. with the fourth stage at 20°F.

CLAY-TREATING

A new departure in clay treating which reportedly combines contact decolorization and fractional distillation in one continuous process has been installed at Standard Oil Company's Richmond refinery. This is the first installation on the Pacific Coast.

In this new system a portion of the lube stock to the fractionator is sent to a mixing tank where the right amount of clay is added. The clay-and-oil mixture is then put through a heat exchanger, then a pipe heater, and finally charged into the fractionating tower at around 675°F. The various cuts are taken from the tower and the heavy bottoms containing the clay are sent to a surge tank and then to a vacuum filter where the spent clay is removed. The clarified bottoms are then sent to storage.

Refinery Development

(Continued from page 39)

ern area and at least two plants in the Mid-Continent. The trend continues to favor bauxite and its magnitude is shown by a 24 percent drop in fullers earth consumption for 1938. Also three of the largest fullers earth producers are interested in marketing bauxite and one is a co-partner in a domestic activated earth concern. The Georgia-Florida type of fullers earth has, however, been improved about 20 percent in adsorptive power by an extrusion process. The change from traditional materials has inspired investigation of other angles in the filtering process. Filter washing is being studied intensively with very interesting and profitable gains in efficiency. In this connection the new Thermofor kiln for clay regeneration will receive a great amount of attention in the coming year. Pilot-plant and commercial units have fully met the designers' claims. Unlike other regenerating equipment used in refineries this kiln was designed expressly for clay burning and is not an adaptation of ore-roasting or other equipment.

Much research is being done to solve problems of lubricant break-down. Oxidation is recognized as the most serious factor in motor oil failure. More balanced refining and blending and the use of additives are factors in overcoming varnish, sludge, and acid formation. Further knowledge will be obtained through improved analytical methods. Hypoid lubricants must now be manufactured to meet the more severe service conditions imposed by the use of hypoid gears for trucks. Passenger car hypoid lubes are not interchangeable for all truck service so new grades are needed. The modern Diesel engine imposes new lubricating problems due to higher speeds, smaller engines, and more severe temperatures and pressures.

PROBABLE TRENDS

It is always interesting to guess at the future but long-range forecasting of petroleum refining is apt to be a guess and nothing more. It is unlikely that many 1920 prophecies came close to 1940 realities. On the other hand, the progressive refiner must study current trends in order to keep abreast of technology and the market. As previously pointed out catalytic methods are in the fore today and are due for much more complete development. Large refineries are expanding and building even more complex units, yet the small refiner whose number is increasing has available most of the modern processes at no sacrifice due to size. This latter point disposes of the view often expressed a few years ago that the small refiner would soon be crowded out.

Automatic instrument control is becoming highly efficient and where applicable will soon be indispensable. Greater safety due to better materials of construction and improved design has made petroleum refining notable in chemical industry. It also ranks second in that field in point of men and money devoted to research. Production of synthetics from petroleum is being investigated the world over. In Germany a sizeable part of the soap industry's fat requirements comes from fatty acids made by oxidizing paraffin wax. In this country the oxidation of distillates and waxes yields acids, alcohols, esters and ketones, many of which are saponifiable and are commercially used in greases in place of natural fats. Among plastics, one of the very newest is a nitroparaffin-aldehyde condensation derived almost wholly from petroleum.

CONCLUSION

This review necessarily gives only the highlights of the year's events showing the course taken by petroleum refining. The factor of constant change to newer and better methods makes itself felt repeatedly. The importance of continued research into chemistry and engineering design cannot be denied. Customer demand for improved quality is making itself heard in every refinery. The development of refining into a chemical industry well founded on chemical engineering principles becomes more noticeable each year.

Equipment Inspection *for* Greater Refinery Safety

P. N. GAMMELGARD
Chief Inspector, Toledo Plant, The Pure Oil Company

STARTING with the premise that a distillation, cracking, or combination unit has been designed under adequate safety factors, the equipment inspected during fabrication and erection, and subsequently operated within the design conditions of pressure and temperature, it might well be asked, "Why does the necessity for periodic inspections of equipment exist?" To a person familiar with refinery operations, the necessity of equipment inspection in the interest of safety is obvious. Whereas the failure of a piece of shop equipment normally results in only an inconvenient production delay, the failure of cracking-plant equipment may result in loss of life, destruction of property and costly shutdowns.

The special hazards of oil refinery operations are attributable to the nature of petroleum and its products. Outstanding in danger is the characteristic of petroleum products to vaporize and produce highly-flammable and explosive mixtures when loosed to the atmosphere. Unconfined, the liquid or vapor is free to ignite either through auto, or self-ignition, or through contact with burner fires, high-temperature process piping, or unprotected electrical equipment. Once the conflagration is under way, control becomes difficult and final results are apt to be disastrous. Obviously, it is to the benefit of all persons concerned to prevent failure and breakdown of equipment. That such responsibility should be centralized is apparent. Thus the justification of equipment inspection by a department divorced from control by the operating or maintenance departments.

CAUSES OF FAILURE

In order to intelligently inspect cracking units, the causes contributing to equipment failure must be understood. For convenience, the contributing causes will be grouped into two classes. In the first class are the human elements inseparable from operation. Representative of this type are errors in operation which are under the control of the operating personnel, such as operating the units beyond safe temperatures and pressures, permitting water to enter the cracking system, and similar faulty practices.

The danger of operating beyond safe pressure is apparent. Fortunately, this danger can be reduced by maintaining relief valve equipment in working order.

The effect of temperature in reducing the strength of metals is not generally well understood and many who would refuse to increase the operating pressure on a tower by 50 pounds per square inch would not hesitate to increase the temperature 50° or 100° F., although the latter procedure might, in certain cases, be hazardous.

The fact that many parts of a cracking unit operate at temperatures above the boiling point of water points out the potential danger of introducing water in any appreciable amount into the system. The tremendous increase in volume which takes place when water flashes into steam may quickly build up pressures which relief valves will be unable to accommodate.

Modern cracking and combination units cannot be made foolproof. Regardless of the thoroughness of inspection, cracking units must be operated by careful, well trained, and "safety conscious" personnel.

The second class of causes contributing to equipment failure is composed of factors which to a large degree are beyond the immediate control of the operating personnel. The adverse influence of these factors on the safety of equipment makes inspection a necessity.

Listed, without attempting to place them in the order of relative importance, they are

1. Corrosion
2. Erosion
3. Oxidation
4. Creep
5. Fatigue Failure

CORROSION

Without question, corrosion causes more damage to refinery equipment than any other single factor. The loss from this source to the refiners in the United States alone is conservatively estimated at $125,000,000 per year. The fact that corrosion occurs under very widespread conditions, attacks in so many different forms, and that the rates are difficult to establish, makes corrosion the No. 1 enemy of safety. Corrosion, whether mild, moderate, or severe, eventually reduces the original wall thickness of piping and fittings, pressure vessels, and heat exchanger and still tubes to a point where continued operation becomes hazardous and equipment failure is bound to occur unless the condition is corrected in time.

The prominence of corrosion has steadily increased within the past decade. This is due in large part to the following factors:

(1). *Development of cracking.* Higher temperatures and pressures are employed than formerly. The effect has been two-fold. Higher temperatures have liberated active sulfur compounds, resulting in increased cor-

rosion rates. Higher pressures have increased the potential danger of equipment failure.

(2). *Increased production of sour crudes.* Many new oil fields are producing high-sulfur-bearing crudes. While the percentage of total sulfur in crude is not an accurate guide to corrosiveness, it is nevertheless an indication. A crude containing 0.4 percent sulfur may be more corrosive than one containing 0.6 percent, though

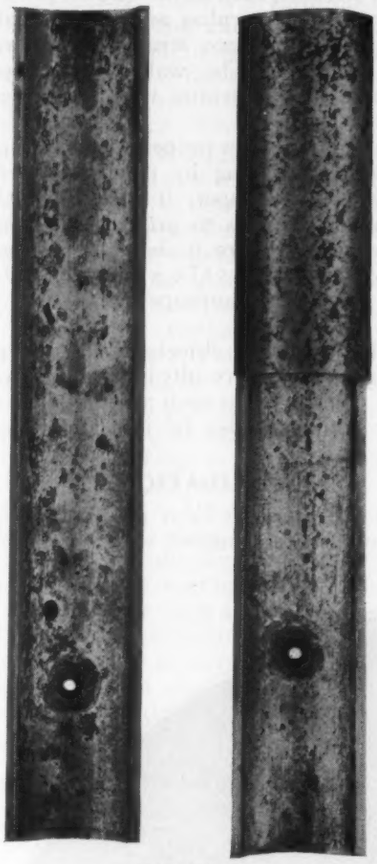


FIGURE 1

such a case would probably be the exception rather than the rule. The type of sulfur compounds, rather than the percent total sulfur will determine the corrosiveness by sulfur attack.

(3). *Acidizing of wells.* In recent years many wells have been acidized with HCl to increase production. Acidizing of wells formerly producing sweet crudes has in some cases resulted in increased corrosion. In a few instances free acid has been found in crude from acidized wells and the pH of the crude has been definitely on the acid side. Normally, no free acid is found, and the explanation for increased corrosion must be sought elsewhere. The generally accepted explanation is that acidizing increases the salt content of the crude and that corrosion is due to the hydrolysis of magnesium and calcium chlorides.

Deviating from the subject of corrosion for a moment, it should be mentioned that salt is also objectionable from the standpoint of salt deposition in crude fractionating towers, heat exchangers and tube stills. Deposition in heat exchangers lowers the heat transfer rates and may result in plugged tube packs. In tube stills, deposition will cause lowered heat-transfer rates, higher tube-wall temperatures with consequent oxidation and generally unsatisfactory operating conditions. Some refiners believe that salt tends to increase coking and that a relation exists between salt content and H_2S corrosion. A salt content exceeding 20 pounds per 1000 barrels of crude will generally prove troublesome. Such a condition can be corrected by employing one of the standard methods of salt removal.

IN ALL FORMS

Refineries are fertile fields for corrosion in all its varieties. Examples of direct chemical action, pitting, dezincification, galvanic action, concentration cell corrosion, corrosion cracking, and corrosion fatigue are common.

Dezincification is a common source of trouble with admiralty metal condenser tubes. Essentially the action consists of the zinc and copper going into solution, the copper alone being redeposited in the form of a spongy mass lacking mechanical strength. Dezincification may be either layer or plug type. Of the two, the plug type is by far the most undesirable as failure is greatly hastened. This type may occur in either acidic or alkaline waters. The tendency of the yellow brasses to dezincify, and for the type to be the plug variety is increased by elevated water temperatures. This is a particularly troublesome and costly type of corrosion and is estimated to account for more than 50 percent of the failures of admiralty metal tubes used in refinery service. Fortunately it can be reduced by the use of red

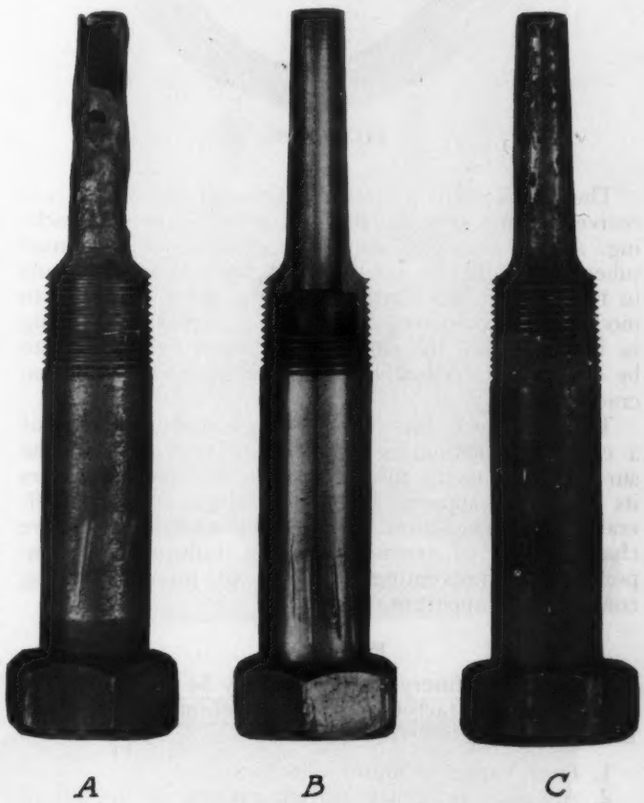


FIGURE 2

brass, which is immune to dezincification attack. It is generally believed that admiralty metal is more resistant to sulfur corrosion than red brass is. Where sulfur attack and dezincification both may be expected, it is claimed by various tube manufacturers that the problem can be solved by using admiralty metal alloyed with either slight antimony, phosphorus, or arsenic additions. Figure 1 shows two 1-inch O.D. x No. 14 BWG admiralty metal tubes which failed as a result of plug

type dezincification after two years service. Note the generally excellent condition of the tubes.

Figure 2 shows three ¾-inch thermometer wells. Thermometer well A is typical of corrosion by untreated cooling water. B failed in untreated gasoline service. C reveals extensive pitting action, service unknown.

FIGURE 3

The exposure of a statically stressed metal to a corrosive medium provides the setting for corrosion cracking. As an example, annealed yellow brass condenser tubes, mechanically cold-worked by rolling the ends in tube sheets, have cracked shortly after exposure to moderately corrosive conditions. Corrosion cracking is intergranular by nature. Red brass is claimed to be superior to yellow brass in withstanding corrosion cracking.

That fatigue failures are hastened in the presence of a corrosive medium is well known. Corrosion of the surface of a metal subjected to cyclic stresses lowers its fatigue resistance. Conversely, fatigue stresses accelerate corrosive action. Deep, steep-walled cracks are characteristic of corrosion-fatigue failures. The importance of preventing vibration of piping handling corrosives is apparent.

EROSION

Erosion in refinery operations may be caused by any one of several factors or by a combination of them. Erosion may result from:

1. High vapor or liquid velocities.
2. Abrasive or gritty matter carried in the oil or vapor stream.
3. The junction of two streams.
4. Coke cleaning equipment.
5. Friction between two objects.

High vapor or liquid velocities occur in slide valves, swaged sections of piping and nozzles. The eroding action of high velocity streams can be very pronounced.

Abrasive or gritty material carried in suspension are effective eroding agents. In one instance, the breaking of a screen at the outlet of a high-pressure reaction chamber packed with fuller's earth caused the failure of a soft iron ring gasket within an hours time. Figure 3 shows a deeply grooved ring gasket. The 3-inch 90° weldell in Figure 4 illustrates the action of small coke particles carried in an oil stream in wearing away the outer elements of the bend, while leaving the inner elements at practically original thickness. The junction point of two streams, such as the quench points at heater outlets, may produce peculiar and unpredictable erosive action. A junction of two streams is shown in half-section in Figure 5. The wall directly opposite the branch stream inlet illustrates what can be expected at such points.

Coke cleaning tools not properly operated can quickly damage tubes and piping by producing deep internal grooves. Left in one spot, it does not take a coke "knocker" many minutes to groove and bulge a heavy wall tube or pipe. Figure 6 shows a half-section of a deeply grooved 4½-inch O.D. x ½-inch wall chromium alloy tube caused by improper operation of a tube cleaner.

Friction between two objects, such as a pipe and a loose support or hanger, results in wearing away the wall of the pipe. The fact that such a condition is frequently partially or wholly hidden by insulation magnifies the hazard.

OXIDATION

Provided a heater has been properly designed, little trouble should be encountered with oxidation. If, how-

FIGURE 4

ever, the throughputs are stepped up beyond the rated capacity of the coils, it becomes necessary to "push" the heaters and as a consequence, firing conditions become far from ideal. Flame impingement is a well known cause of oxidation, though it is by no means a requisite for oxidation. Local overheating as a result of coke conditions or faulty firing may result in a badly oxidized tube within a short period. Under moderate oxidizing conditions, scale will form on the surface of the tubes. The insulating effect of the scale will in turn necessitate higher muffle temperatures in order to maintain the oil line and if the situation is permitted to become progressively worse, a bulged tube will result and ultimately a rupture. The 5-inch O.D. tube in Figure 7 bulged 9/16-inch in diameter and scaled to a depth of 3/16-inch owing to severe firing conditions in a crude tube still operated far beyond the designed rating. Carbon-steel and low-chromium tubes will normally bulge considerably before rupturing and with vigilance on the part of the fireman a unit with a bulged tube can be brought down before total failure of the tube occurs. An example of vigilance on the part of a fireman is given in Figure 8. This 4-inch O.D. x ½-inch wall 1¼ percent chromium, 0.5 percent Moly tube, operating at 1000 pounds pressure, bulged in two spots owing to local overheating caused by excessively heavy coke deposits. The two rings cut from the ends of the bulged specimen show the coke thickness. Figure 9 shows a ring cut from a 3½-inch O.D. x 5/16-inch wall high pressure heater tube which failed in service as a result of a heavy coke deposit. The dotted white circle outlines the inside surface of the tube prior to the bulging caused by too high a tube wall temperature. After bulging started a secondary layer of soft, porous coke formed, and failure occurred soon thereafter. The use of thermo-couples in obtaining tube skin temperatures in zones where coking and oxidation are encountered is of value in determining whether or not the continued operation of a heater is safe.

Continued oxidation trouble in a particular zone would warrant the installation of oxidation-resistant chromium-alloy tubes. The addition of silicon to the intermediate chromium alloys definitely improves oxidation resistance. Calorized tubes have been used with success in combating oxidation.

CREEP

The creep strength of metals was not a matter of much concern to the refiner until the advent of high operating pressures and temperatures. Creep strength is

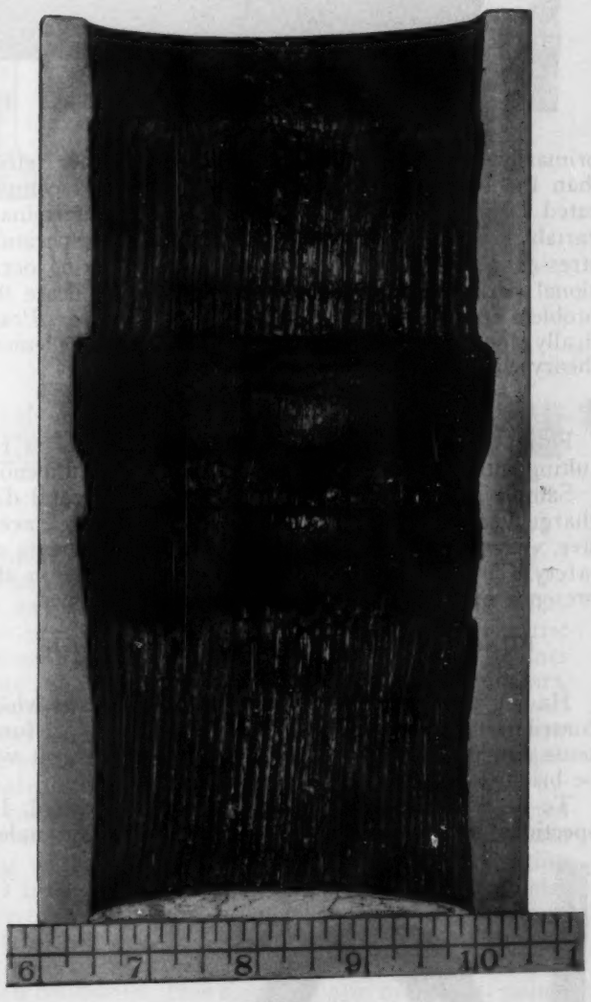


FIGURE 6

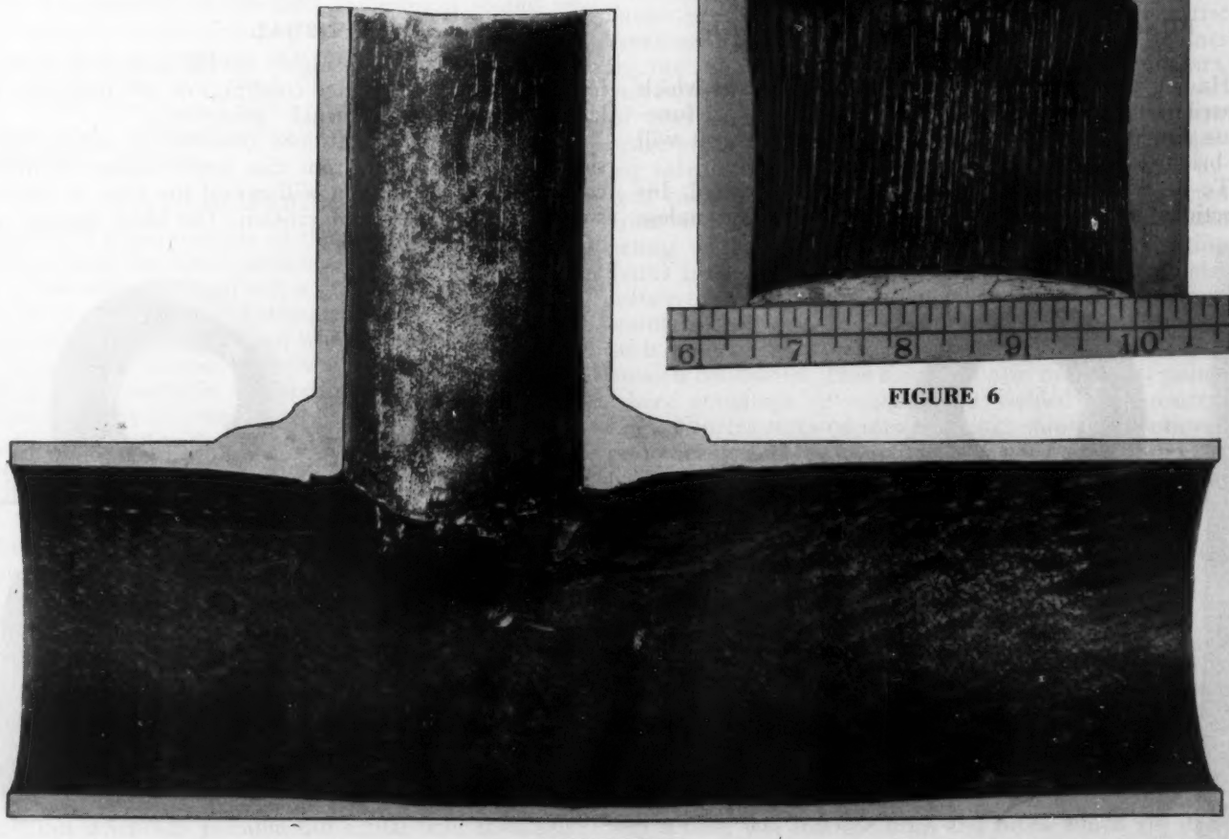


FIGURE 5

FIGURE 7

primarily the concern of the equipment designer rather than the inspector. The designer's problem is complicated by lack of applicable data. Such indeterminate variables as corrosion, oxidation, erosion, temperature stresses, and excessively high heat inputs during occasional periods of heavy coking, greatly complicate the problem for both the designer and the inspector. Practically, the inspector will find it sufficient to supplement theory with experience.

FATIGUE

Fatigue of metals under repeated cyclic stresses resulting ultimately in failure is a common phenomenon.

Sample and instrument lines, pump suction and discharge lines are generally subject to vibration. Excessive vibration should be remedied in the interests of safety. The dangerous combination of fatigue in the presence of corrosion has already been mentioned.

FUNCTIONS AND PROCEDURES OF AN INSPECTION DEPARTMENT

Having taken cognizance of the various factors which contribute to the failure of equipment, the typical functions and procedures of an inspection department will be briefly outlined.

To be effective, inspection cannot be haphazard. Inspections must be thorough and accurate, and unless made periodically, their effectiveness is greatly reduced. For obvious reasons, inspection work should not be under the control of the operating or maintenance departments.

The determination of the inspection and testing periods should be the responsibility of the inspector in charge. The periods so determined will be the result of past findings, severity of operating conditions and potential danger in the event of failure. Until an experience record has been built up, it is certainly better practice to "over-inspect" than "under-inspect."

A typical inspection procedure covers the following points:

1. Visual examination.
2. Drilling and calipering.
3. Hammer testing.
4. Pressure tests.
5. Records and reports.

VISUAL

Visual inspection is a highly useful method of examining in detail the surface condition of all items which lend themselves to a visual "going-over."

It is possible for a trained observer to obtain considerable information from this source alone. In most cases visual examination will reveal the type of corrosion, and the severity of erosion. The ideal manner of

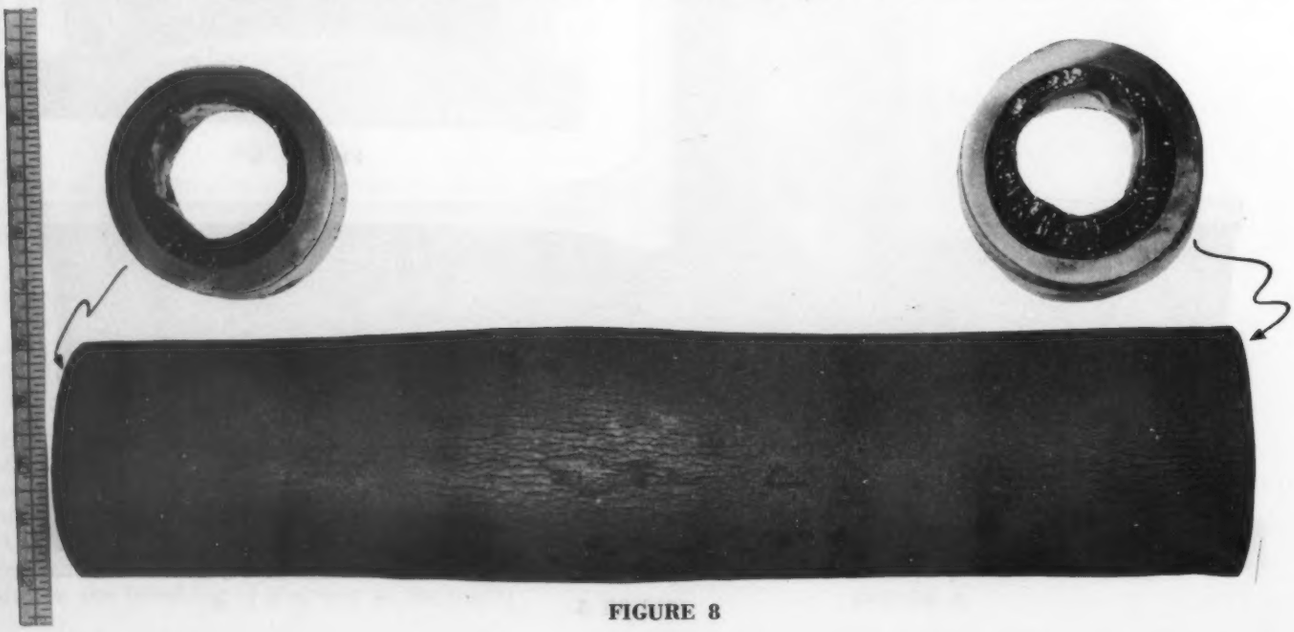


FIGURE 8

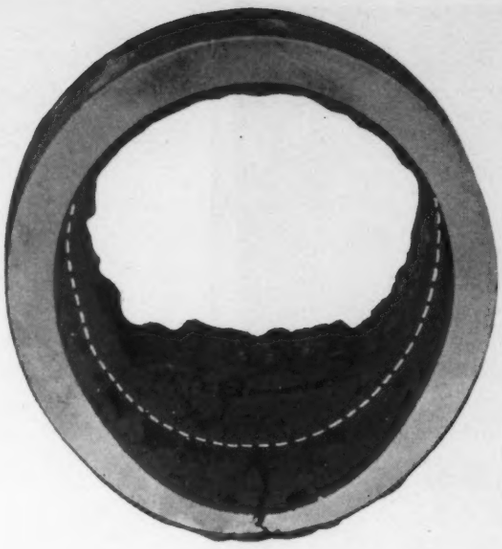


FIGURE 9

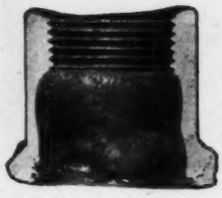


FIGURE 11

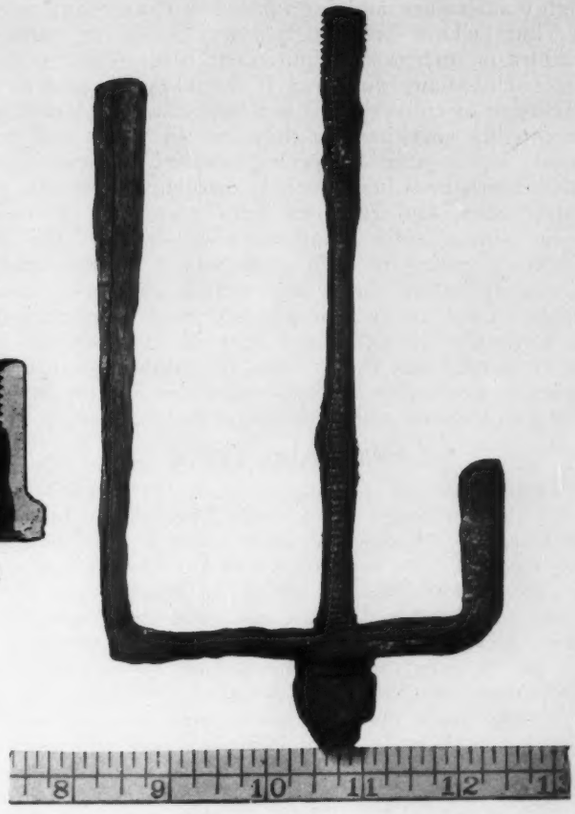


FIGURE 10

preparing steel surfaces for examination is sandblasting, but where this is not practicable, scraping and wire brushing will normally suffice. Defects found by visual examination should be exhaustively investigated and necessary repairs or replacements recommended.

In visually examining towers and evaporators, special care should be taken in the inspection of all welded and riveted joints, and the condition of protective linings, if any. Gannister linings may spall and crack and indications of such action should be looked for. Screens should be installed to prevent spalled pieces from working their way into pump suction lines. Alloy liners should be periodically examined for bulges and cracked welds. Examination of the shell for erosion should be made opposite vapor or liquid inlet nozzles.

Figure 10 is an example of typical HCl corrosion of steel parts in the top trays of crude towers. Visual examination of the shell surface will indicate the points of maximum corrosion at which thickness measurements should be taken.

CALIPERING

Thickness measurements of the shell, and heads, and nozzles should be taken periodically. Where the thickness of the vessel is in doubt, a drilling should be made and the wall calipered. Subsequently the drilled hole should be tapped, plugged, and where conditions warrant it, welded. This practice is frowned on by some metallurgists as it results in localized stress concentrations. Thicknesses may be conveniently calipered through couplings in the shell with a special gage. Between calipering dates, the couplings are bull plugged. This method has the advantage of quickly giving the trend of corrosion, as the measurements are comparable, being taken at the same points each time. An alternate method is the use of highly-corrosion-resistant bench marks, strategically located on the interior surface of the vessel. Measurements are taken by placing a depth gage across the bench marks and measuring the distance to the shell surface. A disadvantage of this method is that the vessel must be entered by the inspector. Under conditions of not having been made gas-free, this would be objectionable. Experience will dictate the best method for obtaining the desired information.

Thickness of piping may be obtained by I.D. measurements, but whenever possible the actual wall thickness should be obtained, owing to the fact that corrosion is seldom uniform. If the wall thickness of piping is obtained by subtracting the calipered I.D. from the O.D. and dividing the difference by 2, a suitable safety factor must be allowed for the possibility of eccentric corrosion. Particular attention should be paid to lines in the sections immediately adjacent to regulators, valves, orifices and sharp turns. In gate valves, the point of maximum loss is normally found in the narrow space between the valve seats. Figure 13, a flow regulating valve, shows the point of maximum loss to be in the web connecting the two seats, as would be expected from the fact that corrosive and erosive forces are acting on both sides of the web. Notice the casting faults in the inlet flange and the large pit in the inlet nozzle. The seats and valve plugs (not shown) were stainless steel and were unaffected. Turbulent flow at such points may result in abnormal corrosion and/or erosion conditions. This condition also prevails at points where couplings or nipples are welded into process lines. Nipples screwed into couplings should be removed periodically and the coupling wall thickness behind the thread engagement carefully checked. Eccentric corrosion or erosion, or a combination of both should be expected. An unevenly corroded ¾-inch coupling in service only 60 days is shown in half-section in Figure 11.

HAMMER TESTING

Hammer testing is a valuable aid to the inspector when properly used. Effectiveness of this method of inspection depends on the judgment and experience of the man who wields the hammer. The weight of the hammer, the size of the pipe, the required wall for the service conditions, the force and ring of the blow are factors entering into reliability of hammer testing. Hammer testing will disclose lines and tubes which are dangerously thin. However, its value is limited in checking

high-temperature and high-pressure charge and transfer lines where exceedingly heavy walls are required. Failure in such cases might occur before hammer testing disclosed any weakness. It should not be used to the exclusion of calipering. It is a particularly valuable tool in roughly checking the thickness of bends and such points where actual calipering is difficult, if not impossible. Horizontal lines, such as distillate condensate and vapor lines, and rundown lines may have corrosion occur almost entirely on the lower half of the line. Hammer testing in such cases would disclose such a condition before calipering would. Similarly, heater tubes do not always corrode and erode concentrically, as is vividly illustrated in Figure 12. It is possible that in extreme cases that results of calipering of heater tubes would not disclose excessive thinness on one side whereas hammer testing would probably do so.

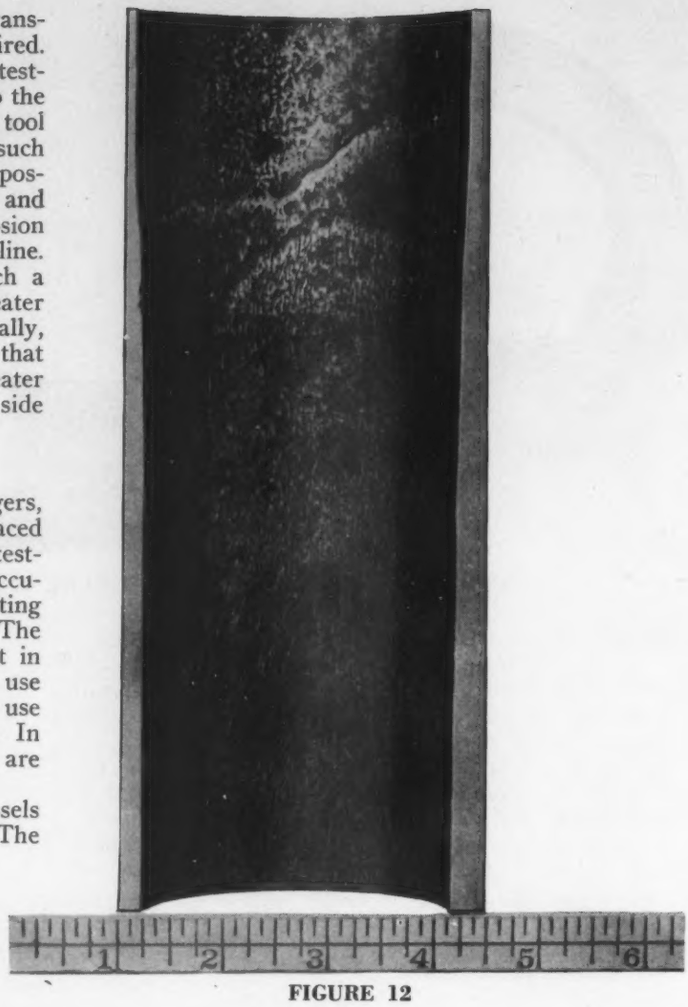


FIGURE 12

PRESSURE TESTS

Testing of all pressure vessels, heat exchangers, heater coils, charge and transfer lines should be placed on a regular schedule. Water is normally used as a testing medium. The pressure applied to towers and accumulators should be 1½ times the relief valve setting times a factor based on the operating temperature. The pressure used in testing heaters may be arrived at in several different ways. One method is to simply use 1½ times the charge line pressure. Another is to use a factor based on the heater outlet temperature. In either case the rolls and holding members and tubes are examined for leaks.

Application of hydrostatic tests to pressure vessels during freezing temperatures is to be discouraged. The effectiveness of the test under such conditions is of doubtful value even though warm water be used. The danger of freezing a nipple or instrument line leading from the vessel to the extent of bursting is ever present. In one refiner's experience a minor fire occurred several

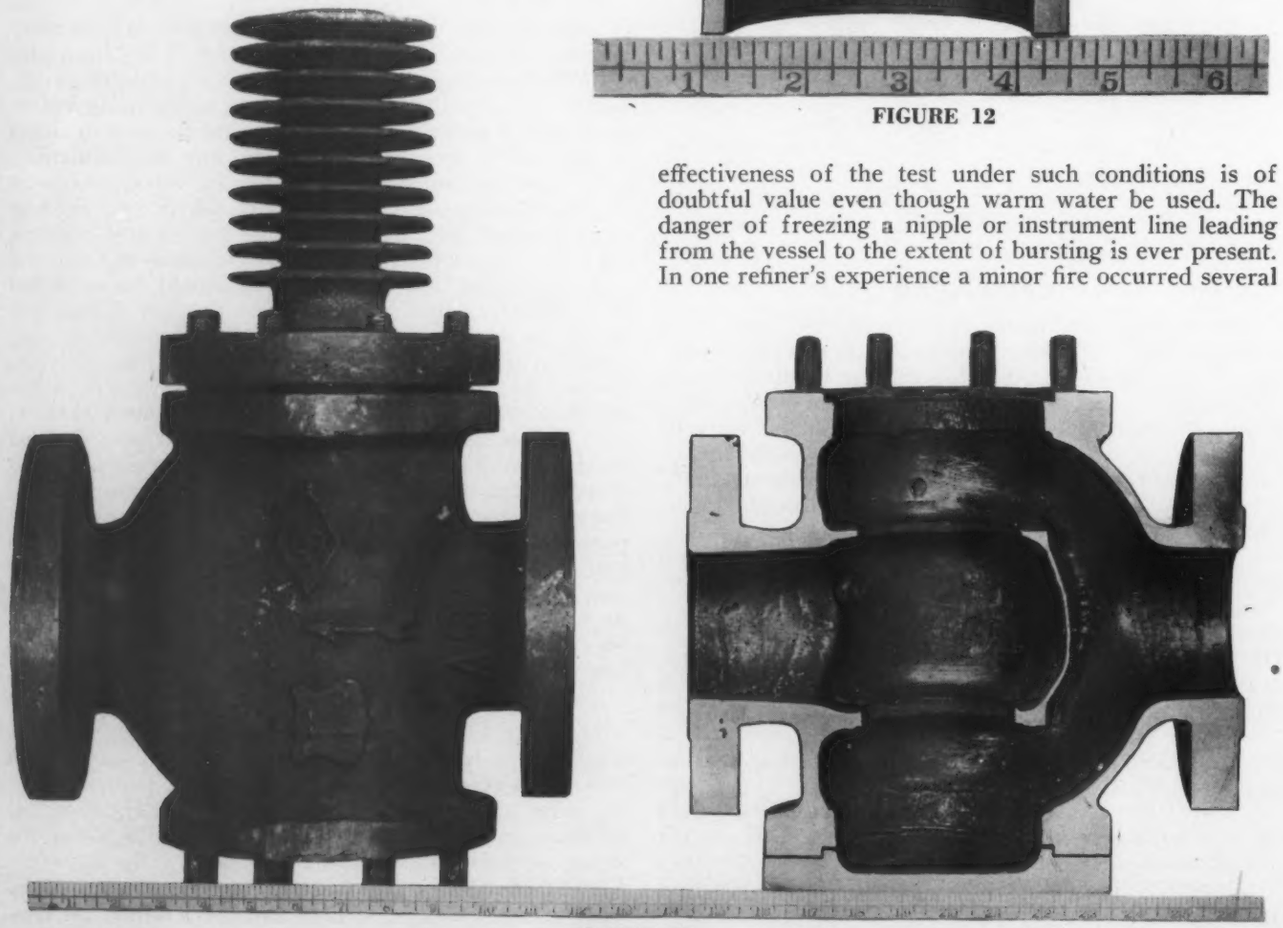


FIGURE 13

hours after the unit had been brought up to temperature and pressure as a result of a frozen "dead end" branch line. Insulation covering the line prevented disclosure of the break, located at the far end of the line until the ice had melted and vapors poured forth, igniting from an adjacent hot line. Annual pressure tests will suffice in most cases, and where semi-annual tests are deemed necessary, they can be scheduled for spring and fall and thereby avoid freezing weather. After hydrostatically testing cracking equipment, care must be exercised to vent the unit and drain completely. The hazard of water in a cracking unit must never be ignored.

The primary function of equipment inspection is the assurance of safety and continuity of operations by the prevention of property destruction or costly shutdowns by reason of equipment failure. In order to fulfill this function and also the secondary functions of forecasting maintenance work and keeping the management informed as to the condition of the operating units, it is not enough that the inspector understand the causes contributing to equipment failure and is familiar with the methods of inspection. It is necessary that the data collected during a periodic inspection be recorded at the time of inspection and subsequently filed. Such a setup requires a filing system in which every heater tube and every section of process piping has an individual record card for the purpose of entering the date of the inspection, the wall thickness, I.D., result of hammer test, and any other pertinent data. Figure 14 illustrates an individual tube record card. It is essential that such a system be simplified. Heater tubes are generally numbered consecutively and tube diagrams drawn for convenience in calipering tubes and maintaining a complete heater tube record. Tubes which are known to be nearing their safe I.D. limit can be kept in mind by use of small red warning tabs attached to the individual tube record card in the index. Where header boxes are infrequently changed, it will be expedient to use small die figures to stamp the tube number directly on the header box. By so doing, both the tubes and header boxes are readily identified, and the possibility of confusing tube numbers on the calipering data sheets is eliminated.

Each run of process piping can be numbered and individual sections lettered. Thus a charge line might be Number 76 and be composed of sections 76-A, B and C. Isometric sketches of piping systems aid in identifying sections and tabulation of data. Such sketches can show the date of installation of each section as well as the weight, standard or extra heavy, and the material specification. They are of additional value in providing an overall picture of the condition of a system. The running record, showing the trend, is secured by reference to the appropriate individual card record.

Each pressure vessel should be assigned a distinguishing number and a file maintained. The file should include data commencing with the initial inspection, such as diameters and wall thickness of nozzles and manways and become a case history of each vessel. This history should be a chronologically arranged list of such items as repairs to welds, nozzles and manways, renewal of couplings, failure or behavior of liners, and replacement of baffles, trays, or bubble caps. Well kept records are invaluable aids in the fight against equipment failure.

Inspection reports to the management must clearly indicate the exact state of the operating units. Recommendations for repairs and replacements should be assigned individual numbers and filed in a follow-up file to insure action being taken. The cases are few wherein the management will over-rule the duly considered recommendations of the inspector. His opinions must be based solely on facts and should present a true, unbiased picture of the condition of the equipment. Nowhere is the saying "misinformation is worse than no information" more applicable than it is to inspection work.

In conclusion, it should be said that no pains, no thoroughness of details, however superfluous they might seem, should be spared in the effort to safeguard human life and prevent property damage. The refinery disasters which occurred only too frequently in the early years of the industry and occasionally occur today in spite of all efforts to the contrary, serve as constant reminders to the inspectors of refinery equipment to be unrelenting in the battle with the forces which cause failure.

Form 76—10M—10-3-34—Poco.

TUBE CALIPERING RECORD

REFINERY_____ UNIT_____ SECTION_____ TUBE NO._____

DATE INSTALLED_____ SIZE AND TYPE OF TUBE_____

DATE REMOVED DESCRIPTION OF FAILURE

DATE	MAX. I. D.	DATE	MAX. I. D.	DATE	MAX. I. D.	DATE	MAX. I. D.	DATE	MAX. I. D.	DATE	MAX. I. D.

FIGURE 14

Elements of Vaporization . . . The Phase Rule

Its Application to Problems Connected With Refining and Natural Gasoline Manufacture

R. L. HUNTINGTON,
University of Oklahoma

THROUGH a lengthy dissertation, J. Willard Gibbs[1] has given the physical scientist and the engineer a simple and very useful tool which can be applied advantageously in the study of many problems involving the design of equipment and everyday plant operation. Failure to observe this phase rule has on more than one occasion caused the loss of thousands of dollars before the resulting difficulties could be uncovered and corrected. Perhaps the reason for this oversight on the part of many engineers is due to the fact that the number of degrees of freedom or variance which go toward fixing the state of a system may be fewer than one would expect at first thought.

DEFINITION OF THE PHASE RULE

It is outside the scope of this paper to go into the long, rigorous derivation of this rule. Stated in simple mathematical form it is as follows:

$$F + P = C + 2$$

Where F = the number of degrees of freedom which a system may have such as temperature, pressure, and the composition of any component in any one phase. When a certain number of degrees of freedom has been assigned to a system, it is said that the system is fixed.

P = number of phases in the system. A phase is any homogeneous mixture such as vapor, liquid, or solid phase. Ordinarily there is only one vapor phase, while there may be two or more liquid or solid phases present.

C = the number of components or chemical compounds which are required to make up the system.

This rule applies only to systems in which the different phases are in equilibrium with each other. It may be observed that the degrees of freedom pertain to intensive properties such as pressure, temperature, etc. and not to extensive properties of the system. Since the steam boiler is such an important part of any plant or refinery, its performance might be considered before the more complex systems are tackled.

APPLICATION OF THE RULE TO THE STEAM BOILER

The best method of gaining an understanding of any principle or law is to apply it to a number of different cases:

Example 1: If a boiler, Figure 1, containing liquid water and saturated steam is operating at 350°F., it may be readily seen from the phase rule that the state of the system is fixed. In this case there are two phases present, namely, liquid water and steam or water vapor. There is only one component or chemical compound, namely, water. By substituting these values in the equation representing the phase rule, it is seen that there is only one degree of freedom permissible, but since the temperature has been fixed the equation is balanced and the system is fixed. By referring to the steam tables,[2] it is seen that the saturation pressure on the system is 134.62 pounds per square inch absolute.

Conversely, if the pressure for such a boiler had

FIRST OF A SERIES

THIS series of papers has been prepared for a three-fold purpose:

1. To provide the man in the plant or refinery, who has had a year or two of college work, with certain tools and methods needed in the solution of engineering problems.

2. To enable the graduate engineer to review some of the principles he learned in college.

3. To give the plant man who is planning on returning to college or studying in vocational classes, a chance to acquire some skill and practice in making quantitative calculations.

The author wishes to make it clear that the study of these papers will not take the place of classroom instruction in engineering. He does feel, from his own experience in the plants, however, that these papers will help in a measure to give the engineer and operator some idea of the laws governing the behaviour of petroleum hydrocarbons, and the quantitative method of attack in solving engineering problems pertaining to certain unit processes and in particular to vaporization.

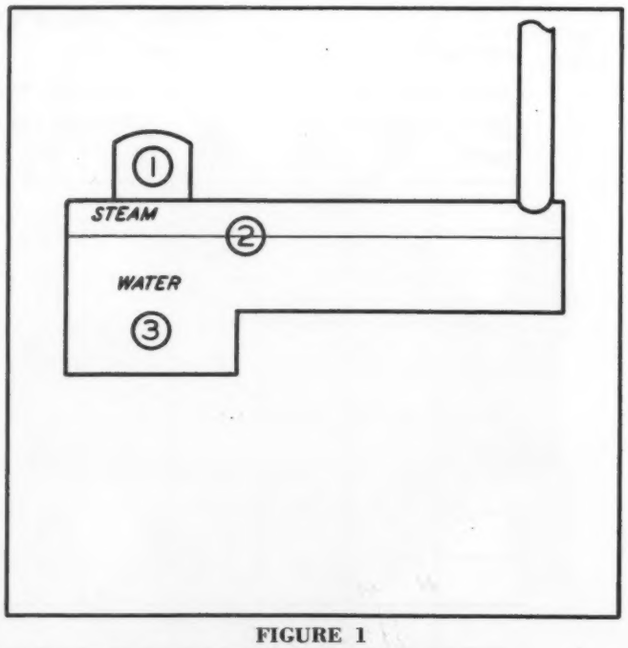


FIGURE 1

(1) Pressure = 134.62 lbs. minus fluid heat of steam.
(2) (Equilibrium at interface) Pr. = 134.62 lbs. per sq. in. Temp. = 350° F.
(3) Pressure = 134.62 lbs. plus fluid head of water.

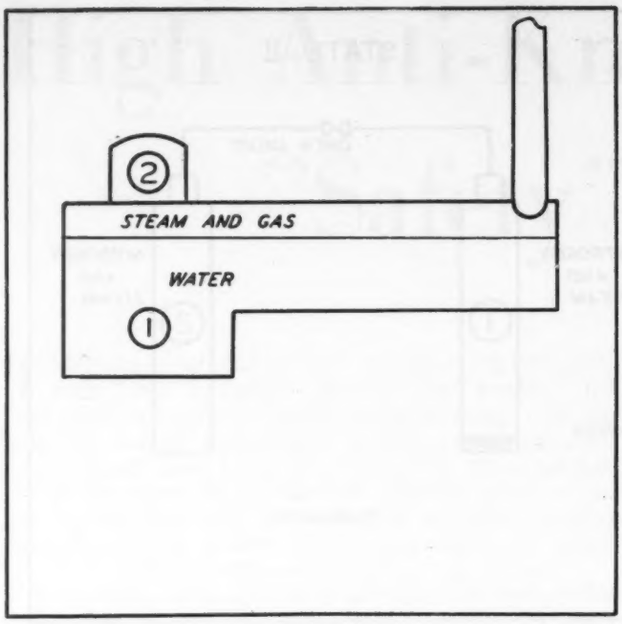


FIGURE 2

Vapor Space

	Partial Pressures	Volume %		Partial Pressures
Steam	= 149 lbs.	99.33	Water	= 149 lbs.
Inert Gas	= 1 lb.	.67	Dissolved gas	= 1 lb.
Total Pr.	= 150 lbs.	100.00		150 lbs.

been set at 134.62 pounds per square inch absolute. the state of the system would have been fixed and the temperature would be 350°F.

Example 2: If a vessel is filled with water vapor or steam only under a pressure of 100 pounds absolute, the state of the system is not fixed since in this case there is only one phase present and one component. This means that the temperature must be fixed in order to fix the system, provided that temperature is 327.83°F. or higher. If the temperature is lower than this level, steam alone could not exist under such conditions.

Likewise, if a vessel were filled with water at 100 pounds gage, the system would not be fixed unless the temperature were specified. In this case the temperature would have to be 327.83°F. or lower, since any attempt to raise the temperature above this level would cause an increase in pressure or the formation of two phases, if the pressure were held constant.

Example 3: If a steam boiler, Figure 2, is operating with a pressure of 150 pounds per square inch absolute and a temperature of 357.9°F., it can be seen from the steam tables that the pressure on the boiler is higher than the corresponding saturation temperature which is 358.43° F. This discrepancy would be an indication that some inert gas, such as air or carbon dioxide, was present in the system. In order to determine the amount of inert gas present in the steam space, Dalton's Law of Partial Pressures can be applied. The water itself would be exerting a vapor pressure of 149 pounds in the liquid, (and the dissolved gas 1 pound pressure) while the water vapor in the steam space would be exerting the same partial pressure, 149 pounds. This would mean that the inert gas was exerting one pound of pressure in the vapor space or 1/150 parts of the total pressure in the vapor space. Since the pressure exerted in the vapor space is proportional to the number of molecules present, and in turn the number of molecules are proportional to the volume occupied by either gas, the inert gas would represent 0.667 percent of the total volume in the vapor space. This same principle involving the Law of Partial Pressures is applied in the operation of vacuum evaporators for the refining of sugar. Knowing the boiling point of the sugar solution at a definite pressure, the sugar manufacturer can tell whether air has leaked into the evaporator by keeping a close check on the temperature and the pressure of each vessel.

Example 4: The Phase Rule and the Law of Par-

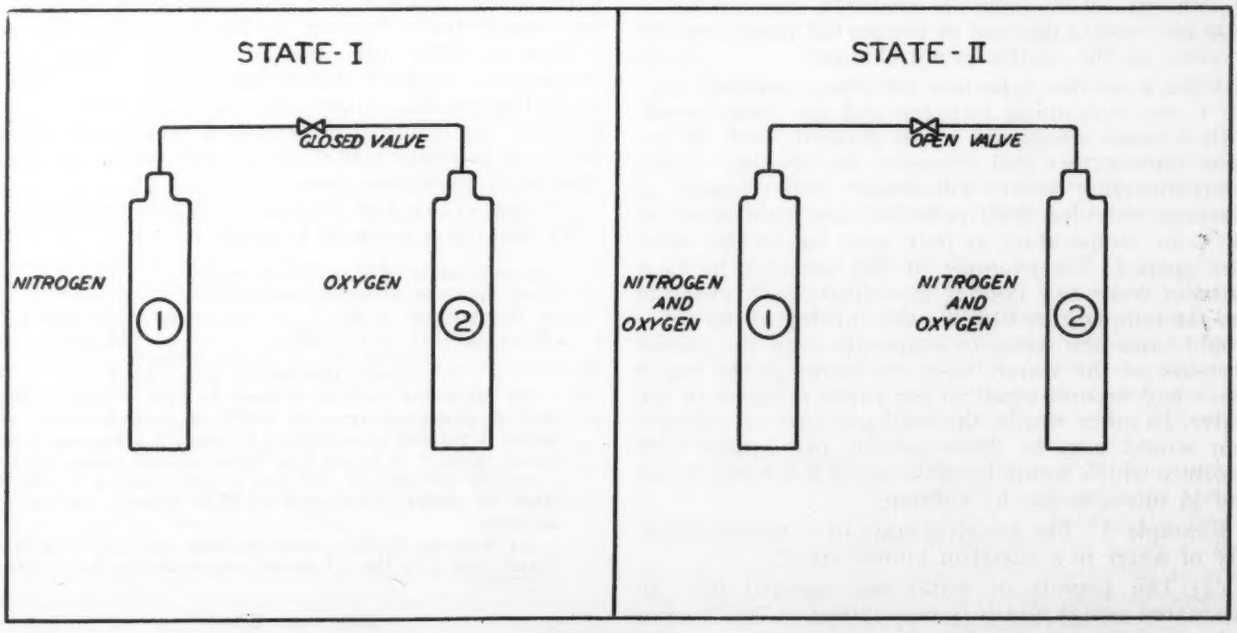


FIGURE 3

STATE I	Partial Pr.	Total Pr.		STATE II Partial Pr.		Total Pr.
(1) Nitrogen	14.7 lbs.	14.7 lbs.	(1) & (2)	Nitrogen	Oxygen	
(2) Oxygen	14.7 lbs.	14.7 lbs.		7.35 lbs.	7.35 lbs.	14.70 lbs.

Total Pr. on each container = 14.7 lbs. in both cases.

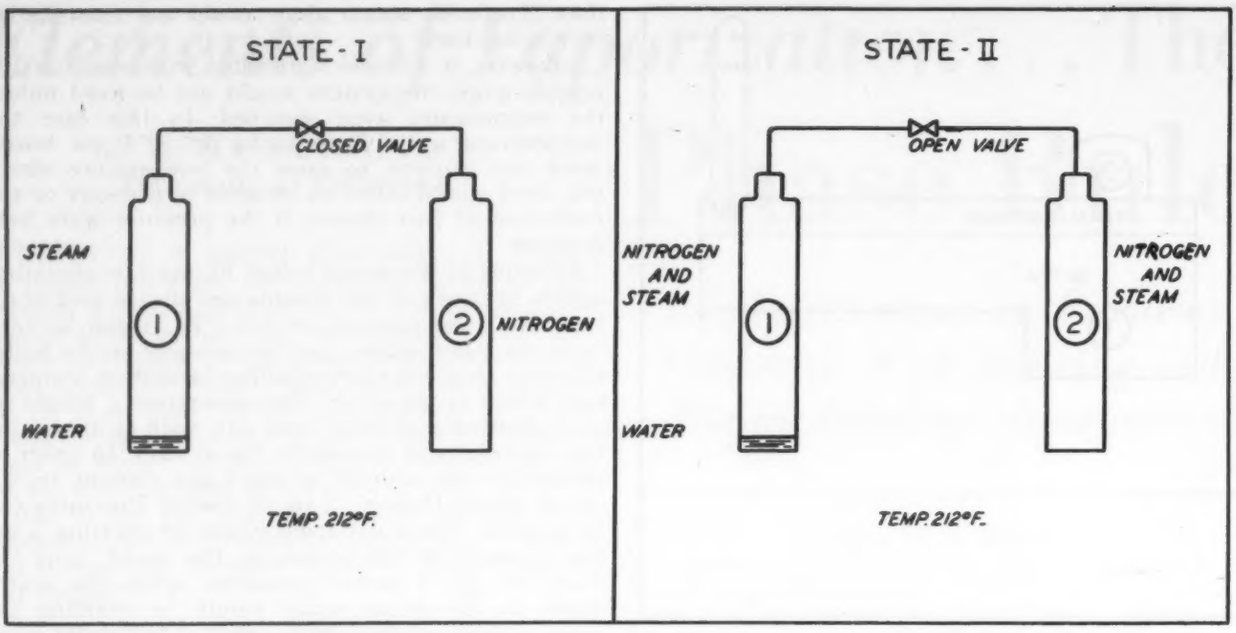


FIGURE 4

STATE I	Partial Pr.
(1) Water or Water Vapor	14.7 lbs.
(2) Nitrogen	14.7 lbs.
Total Pr. on each container	= 14.7 lbs.

STATE II	Partial Pr.
(1) Water or Water Vapor	14.7 lbs.
Nitrogen	7.35 lbs.
(2) Nitrogen	14.7 lbs.
Water Vapor	7.35 lbs.
Total Pr. on each container	= 22.05 lbs.

tial Pressures can be applied to the isothermal mixing of gases and vapors:

If two cylinders of equal size are interconnected with a valve, Figure 3, one cylinder containing nitrogen gas and the other oxygen gas, both at the same temperature and pressure, the pressure on the system will not be changed by opening the valve. The nitrogen gas will diffuse into the oxygen cylinder and vice versa the oxygen gas into the nitrogen. In this process the partial pressure of each gas is reduced to one half of its original pressure, but since the total pressure is the sum of the partial pressures, the pressure on the system is not changed.

If the same two cylinders are interconnected, Figure 4, one containing nitrogen and the other steam with a small amount of water present, both at the same temperature and pressure, the opening of the interconnecting valve will result in a change of pressure provided both cylinders are maintained at the same temperature as they were before the valve was opened. For example, if the pressure in each cylinder were 14.7 pounds per square inch absolute and the temperature 212° F., the opening of the valve would cause the water to evaporate until the partial pressure of the water vapor or steam in the vapor space had become equal to the vapor pressure of the water. In other words, the total pressure on the system would now be 22.05 pounds per square inch absolute which would be made up of 2/3 water vapor and ⅓ nitrogen gas by volume.

Example 5: The physical state of a definite quantity of water in a vessel of known size.

(a) Ten pounds of water are injected into an evacuated vessel which is maintained at 350°F. The volume of the vessel is 10 cubic feet.

(1) What will be the pressure on the vessel?
(2) What percentage of the water will be evaporated?

(b) Same as (a) except one pound of water is injected.

(c) Same as (a) except fifty pounds of water are injected.

Before the phase rule can be applied to the above cases, it is first necessary to determine the number of phases present. The overall specific volumes for (a) (b) and (c) are 1.0; 10.0 and 0.2 cubic feet per pound respectively. In the steam tables[2] it is found that saturated steam (steam in equilibrium with water) has a vapor pressure of 134.62 pounds per square inch absolute at 350°F., and a specific volume of 3.338 cubic feet per pound. Water at a temperature of 350°F. has a specific volume of 0.0181. Since the specific volumes for parts (a) and (c) fall between the values for saturated steam and liquid water, it is evident that steam and water are both present in these two cases.

Solutions: (a) Ten Pounds of Water Injected

By making a material balance:

Let x=pounds of water evaporated
10—x=pounds of water condensed
cu. ft. of water + cu. ft. of sat. steam=total space
$(10-x)(.0181) + x(3.338) = 10$ cu. ft.
x=2.96 lbs. of steam formed
or $2.96 \times 100 = 29.6\%$ evaporated

(b) Since the specific volume of 10.0 is greater than that of saturated steam at 350°F. it is evident that the water is present as saturated steam. By referring to the steam table it is found that super-heated steam having a specific volume of 10.0 and a temperature of 350°F. must be under a pressure of 47.22 pounds per sq. in. absolute.

(c) Solving in the same manner as part (a) it is found that 2.74 lbs. of water evaporate to form steam or 27.4%.

Literature Cited

[1] Gibbs, J. Willard, Trans. Conn. Acad. Sci. 3,228 (1876)
[2] Keenan, Joseph H., Steam Tables and Mollier Diagram, A.S.M.E. 1930

The next paper will contain a further discussion of the phase rule and its application to the study of more complex systems such as those containing two or more hydrocarbons.

High Anti-Knock "Safety" Aviation Fuel

M. G. VAN VOOHIS

Translated from Petroleum Zeitschrift XXXV, No. 34

THE price of 125-octane gasoline has dropped from $3600 to $50 per gallon. The "Yankee Clipper" with its four motors has made crossings over the Atlantic, using exclusively a 100-octane gasoline, which some time back was valued at $25 a gallon.

Various signs in the field of aviation point to the use in the very near future of 24 or more cylinder engines of 2000 to 5000 R.P.M., equipped for direct injection of high anti-knock "safety" gasoline.

New tests and a still more advanced technique for rating the present day 100-octane (or higher) gasoline must, however, be developed. This can be accomplished either by the use of other reference fuels or by the use of a compressor ahead of the engine.

During June of 1939, valuable papers were read at the San Francisco meetings of the Society of Automotive Engineers covering this subject.

It can be said that one conclusion to be derived from the many discussions seems to be that the solution of the problem of aviation fuels and their better utilization in the modern multi-cylinder engine is mostly viewed in relation to replacing the carburetor with a device for direct injection.

A saving of 5 percent gasoline is secured by the use of direct injection of the fuel, this being quite appreciable in the field of aviation mechanics. Another advantage is in testing work where the multi-cylinder engine can be easily replaced by a single-cylinder engine, lowering the cost and simplifying the test procedure.

LESS VOLATILE FUEL

The direct-injection motor is manufactured extensively in Germany and its use will no doubt result in the utilization of a far less volatile fuel than gasoline, resulting in the wide adaptation of this type of motor. The motor functions at once with any setting of the injection pump which is of paramount value in airplane flights. From a military point of view, it can be mentioned that this motor allows the pilot to approach his objective in gliding formation absolutely silently once he has attained a predetermined height. It is also important in similar type planes to point out the great fire hazard when using very volatile fuels, their hazardous storage in the supply tanks and the use of complicated feed systems. The use of "internal cooling" is more easily obtained, since regulation of the injection is easier and safer when controlling the single air inlet.

The principal difficulties at present are securing the proper mixture of air and fuel at the start, during flight, and when flying at rapidly changing altitudes. Considerable work will be necessary to determine the correct position of the injection nozzle in the cylinder-head. In no case must the fuel be sprayed directly against the cylinder walls, otherwise the lubricant-film will be washed away. The best position of the nozzle is in the middle of the cylinder-head, whereby the stream is directed to the bottom of the cylinder by a narrow baffle plate arrangement.

It is apparent that the next few years will see the entry into military science planes equipped with increasingly higher R.P.M. motors, (2000-5000) and development will necessarily follow in this direction. These motors will undoubtedly be fluid cooled. The long sought development of finally placing the engine inside of the wing appears, however, to be as far from realization as it has heretofore.

SPECIAL FUELS

Fuels developed for record flights, which are produced only for this purpose can not be used, of course, for other purposes. Such special mixtures are commonly mixtures of benzine—benzole—alcohol blends containing lead tetra-ethyl. The alcohol is added in order to lower the temperature of the air-mixture, and in this way to raise the charging density.

In Table I are shown the compositions of various special fuels.

Fuel No. 1 was used for the Rolls Royce motor which won the race in the 1929 Schneider-Pokal event, and later established the world's speed record. This engine was further perfected and won the speed record in 1931.

Fuel No. 2 was derived from No. 1 fuel by adding 100 percent methyl alcohol. The No. 3 fuel used in the races was developed from No. 2. It showed unsatisfactory performance as to its capacity to feed all cylinders simultaneously, but performed satisfactorily at full capacity, at maximum speed and increased the world's speed record to over 400 miles per hour.

No. 4 fuel was used in the 2800 R.P.M. Fiat motor of the Italian Aviation Corps, which attained a new world record. Fuels 5, 6, and 7 were recently developed from No. 2 and are to be used for water cooled very high efficiency motors. It is interesting to note that these three fuels secure the highest energy output due to their high methanol content.

The development of the compression-ignition type of motor has not advanced in similar fashion. The main difficulty, which had not yet been overcome, is the low energy output when starting. For

complete combustion, a considerable excess of air is needed, making an increased energy-output dependent on the efficiency of the compressor, especially in the case of the "two-point contact" motor.

FIRE HAZARD REDUCED

The greatest advantage which this motor has shown all along is its relatively low fuel consumption curve, and its great capability in operating over a wide range of conditions and speeds without noticeable difference in specific fuel consumption. The break-down of electrical ignition, and the protection of radio equipment are other advantages. The decreased fire hazard alone would not have proven sufficient for the unlimited and broad adaptation of this motor.

In papers read at the various A.P.I. sessions, the point was finally brought forth that the present procedure for octane-rating will have to be replaced by one comprising preliminary compression or supercharger. It was also proposed to enlarge the octane-scale so that 3.75 c.c. per gallon of lead tetraethyl be added to heptane as well as to the iso-octane. There is a distinct necessity for a fuel still better than iso-octane.

Safety fuels to reduce fire hazards show considerable promise. The self-ignition temperature (spontaneous-ignition temperature) for a series of high anti-knock safety fuels is much higher than that of Diesel fuel, and their use is preferable to that of a Diesel engine. Comparative tests show that the safety-fuels compare very favorably with gasoline fuels. Further developments and exacting tests will be of great value.

High anti-knock safety fuels show flash points of 100° F. and higher, being only slightly below the Diesel fuels in this respect, but show a much higher spontaneous-ignition temperature. Such fuels were first proposed by Ferrier in France and were used regularly in flights between London and Paris. No doubt these fuels showed an octane value of below 40. The first hydrogenated safety fuels were manufactured by Standard Oil Development Company in 1929. They comprised almost entirely an aromatic type of hydrocarbon and had an octane rating of about 90. These fuels proved, however, to be difficult to handle in comparison to the usual gasolines. Due to a lack of interest in those years, their manufacture was not pushed.

Recently, Ethyl Gasoline Corporation has carried out tests on fuels, some of which were entirely paraffinic and others entirely aromatic. Both types had flash points around 110° F., and were absolutely fluid at 100° F. A leaded paraffin-type of safety fuel of 100 octane showed in two different test engines a somewhat lower consumption than did a 100-octane gasoline.

Those engines developed and built for the use of safety fuels require a gasifying and easily volatilizing fuel in order to give quick starting. Experience shows that ethyl ether is better suited than petroleum ether of a similar boiling point. Gases, even like ethylene should also be considered. It was proposed to build into the engine a small electrically-heated cracking coil for the purpose of cracking either the safety fuel or the lubricant at the start. Even though such an arrangement would take up considerable space and have appreciable weight, nevertheless it would be simpler than to equip special pressure tanks to store gases or very low-boiling liquid fuels. One could do away with the so-called "starting fuels" as well as their manufacture and storage.

AROMATICS UNLIMITED

The only unproven or untested problem as yet dealing with the injection motor for safety fuels is the injection mechanism. After considerable experience in their use and application it can be said that at present, the injection pumps and nozzles found in the open market meet all the requirements. (This does not apply to the German experience although Bosch Company, as announced, has developed a very efficient and compact injection mechanism.)

While safety fuels of 75-95-octane rating in the past were mostly aromatic oils, it appears that safety fuels are now being brought to the front which are paraffinic, containing lead tetraethyl and are 99-octane. Nevertheless, these fuels are not being produced in any large volumes, while the manufacture of straight aromatic fuels are practically unlimited.

The usual run of safety fuels show a boiling range of 320° F. to 400° F. (A.S.T.M.) and flash point of around 110° F. Any decrease in flash point or increase in B. P. will of course be undesirable both from the standpoint of safety and of good operating conditions.

TESTING METHODS

The use of the standard mixture of heptane-iso-octane as a reference fuel appeared satisfactory until 100-octane gasoline came to be universally adopted.

The best way to improve the present method ap-

TABLE I

Analysis of Special Fuels for Race Cars

Fuel No.	1	2	3	4	5	6	7
Straight-run 74 Octane Benzine (percent)	....	....	....	55	....	....	....
Light spirits (B. P. 25-65 °C.) (percent)	....	....	....	....	20	20	....
Benzol (percent)	78	70	30	22	60	60	70
Methyl Alcohol (percent)	....	10	60	....	20	20	10
Ethyl Alcohol (percent)	....	....	....	23	....	....	....
Acetone (percent)	....	....	10	....	....	....	....
Light spirits (0.680) (percent)	....	20	....	....	....	....	20
cc. Pb. Tetraethyl per Imp. Gallon	4	4	5	7	60	4	7
cc. Pb. Tetraethyl per U. S. Gallon	3.3	3.3	4.1	7.8	8.3	3.3	5.8
Spec. Gravity 60 °F	0.833	0.828	0.824	0.770	0.831	0.831	0.828
Water tolerance	0.0	0.5	14.3	1.7	1.1	1.1	0.5
A. S. T. M. Octane No	96	95	92	90.5	96	95	96
Octane No. without Lead	91.5	92.5	92	88	93	93	92.5
B. t. u., per Gallon	154472	146750	104580	139777	137120	137120	146750
Spec. Heat (B. t. u., per Gallon)	1377	1615	2887	1522	1678	1678	1615

pears to be the use of a supercharger or compressor, though perhaps a costly and cumbersome arrangement. A change in the present methods is necessary since it is now known that knock-tendencies drop off with an increase in cylinder temperatures, that knock increases with the rise in density or pressure of the incoming mixture, that there are difficulties with aromatic fuels, that there is a decrease in relative anti-knock value with any increase in pre-ignition, and that the temperature of the fuel-mix is as yet an uncertain factor.

For the time being one tried the procedure of using as a reference fuel an iso-octane containing increasingly larger amounts of lead tetraethyl. This procedure has the disadvantage that the anti-knock value does not increase continuously; for instance, one also is acquainted today with fuels of higher anti-knock than iso-octane plus 0.4 c.c. T.E.L. per liter, and which respond very well to the addition of lead. It is very probable that one of these liquids mixed with n-heptane will become the reference fuel of the future.

The determination of anti-knock values in a practical test in the motor removes to a great extent the exacting technique difficulties of a test engine. On the other hand, it is claimed, the octane rating as determined in a test engine does not at all correlate with the value found in a practical engine test-run.

The U. S. Army Corps personnel head at the A.P.I. meeting brought out points somewhat at variance with those proposed above. He contended there was no good reason for divergencies between distillation data and knock rating. According to his view, the unfortunate differences of results are partly due more to a discrepancy between various laboratories than to a difference in the construction of the same make of test engine. He thought the differences in the data could also be traced back to the undetermined influence of the distillation temperature on the fuel-mix distribution in the individual cylinders. He hoped, as a problem on his present program to be able to overcome these difficulties during the present year.

Concerning the installation of a preliminary compressor or supercharger in anti-knock determinations, he reported likewise his view that despite the unhandy arrangement, this would be the best solution in the end.

The effect of various type fuels on the average temperature of the cylinder should not be overlooked in any case. The U. S. Army Air Corps' method of measuring these temperatures will form, according to his views, a good foundation for standard test procedure.

THE U. S. ARMY AIR CORPS METHOD OF TEMPERATURE MEASUREMENTS

In the region of "knock" there develop high cylinder temperatures and black exhaust fumes when using paraffinic hydrocarbons. The black exhaust smoke indicates incompletely burned fuel.

The tendency of aromatic fuels to cause overheating of the cylinders makes these fuels undesirable in aviation motors, since this creates great difficulties in the removal of increased heat output, as far as the cooling system is concerned.

Since the heat value of these aromatic fuels is lower than that of the paraffinic oils (together with a higher specific fuel consumption for the aromatics), it appears that there is no valid or economic reason for using such fuels except in a few rare and exceptional instances.

The cylinder temperatures should be simultaneously recorded with the knock intensity, in the future test engine equipped with a supercharger. The engine should also operate under a slight suction, at the point at which the test fuel gives a definite knock intensity; the carburetor being used then in addition for the leanest fuel mixture. The reference gasolines are next tested under the same conditions wherein the air-fuel mixture is injected in similar fashion. The reference benzine, which shows the same average cylinder temperature at equal or similar knock intensity determines the value sought.

The idea of using safety fuels to increase the safety of airplane operations is so important as to necessitate the most thorough scientific and mechanical investigations. It is of course understood that such safety fuel be a highly efficient and otherwise scientifically refined product showing no lowering of engine efficiency.

These recommendations of the experts of the U. S. Air Corps pointed out that the measurement of cylinder temperatures in determining knock intensity did not mean a complete abandoning of knock rating procedure based on "audible knock." The tendency of a fuel toward overheating the cylinders and to preignition has no great significance in an automobile engine, while it is very important in the case of airplane engines. The recommendations of the air corps to use a combination of measurement of knock intensity and average cylinder temperature appears therefore very valuable.

One can take for granted that the cost of safety fuels will be considerably less in the very near future. One can expect that a safety fuel on aromatic basis of 87 octane will cost about the same as the gasolines of 87-octane value used at the present time.

The safety fuel will show a lower heat value than straight-run benzine; nevertheless this difference will be readily offset by the absence of evaporation losses in the supply tanks during flying.

Application of X-Ray Inspection *to* Oil Refining Equipment

HERBERT R. ISENBURGER
St. John X-Ray Service, Inc.

WHEN Professor Roentgen (15)[a] announced 44 years ago, that he had discovered a light ray which would penetrate solid objects and that he had made it possible to see through solid sheets of metal, his discovery was regarded as of great interest to scientists, but of little value for practical purposes. Probably it never occurred to him that some day X-rays would be used as a regular inspection tool in industry and that they would play a part in the production of equipment and installations of more dependable character. Within recent years, however, engineers have been able to make practical use of it for the inspection of castings, forgings, welded structures, and the like. Of great value is this inspection tool to the refining industry where actual savings have been effected or safety achieved because X-rays were able to prove the soundness of material.

Concerning their nature, X-rays are electromagnetic vibrations in every way similar to those of ordinary, visible light except that the average wavelength is only about 1/6000 as great as that of yellow light. As to their generation, X-rays are emitted whenever matter is bombarded by cathode rays, each element having its own characteristic $K\alpha$ radiation.[2] The essential parts of an X-ray-generating apparatus are, therefore, a source of electrons proceeding from a cathode, which is a hot-wire filament in a vacuum tube; a target or anticathode or anode in the path of the cathode ray stream; and a means of applying a potential difference between the cathode and the target which will accelerate the electrons to the required velocity during the passage across the intervening space.

It is impossible to give a complete description of all the properties of X-rays and the various applications here; they may be found in our book on Industrial Radiography, John Wiley & Sons, New York. In their application to refinery equipment, we are concerned primarily with the properties of differential absorption of the rays in matters and the blackening of the photographic film. The usual way of recording X-rays is by the "shadow picture" or exograph, a term created by the writer, registered on a photographic film. As with ordinary photographs, darker regions on the negative or lighter regions on the positive mean that more radiation has passed through the object and that it is more transparent to the rays at that point. Porosity in metal will show up as dark, small spots on the negative and cracks appear as dark fine lines whereas excess metal or high atomic weight impurities appear as lighter areas since more rays will be absorbed by the heavier material.

By far the majority of large objects radiographed up to the present have been castings. Whether justi-

[a] This and following numbers are references to Bibliography on Industrial Radiography, by Herbert R. Isenburger, American Documentation Institute, 2101 Constitution Avenue, Washington, July, 1938.
[2] The 92 Elements, St. John X-Ray Service, Inc., Long Island City, 1936.

FIGURE 1 (a)
Ell Fitting marked for X-ray inspection.

FIGURE 1 (b)
Cold-worked crack in cast steel.

FIGURE 2 (a)
Gas inclusion and shrinkage cracks in cast steel.

fied or not, there is a tendency on the part of designing and operating engineers to place confidence in forgings without subjecting them to X-ray inspection. On the other hand, they prefer castings for many services in oil refinery installations, because castings may be cheaper even when they are X-rayed and the additional cost of the radiographic inspection is taken into account. Inspectors are strengthened in this tendency when assured of the quality of the castings. The degree of this assurance depends upon their faith in the manufacturer and his workmen, and upon tests applied to castings. The usual physical test consists in applying hydrostatic pressure to a value well in excess of the maximum intended working pressure. If the casting does not fail at this time, and if there is no visible evidence of damage as a result of the test, the casting will be accepted with the assumption that it has no serious defects and that it will stand the working pressure during a reasonable operating life.

AN EXAMPLE

This is not a wholly safe conclusion. For example, the ell fitting shown in Figure 1 was subjected to a hydrostatic test and apparently withstood it successfully. However, subsequent X-ray examination disclosed that the test has produced or extended a crack which had started from a small gas hole or an inclusion of a foreign substance, and which had progressed about two thirds of the way through the outer portion of the wall of the fitting. It is possible that because of this defect, the ell would have failed while in service, and serious damage and injury to personnel and equipment would have resulted.

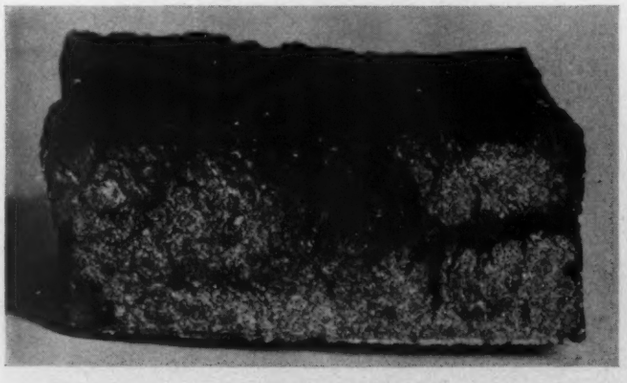


FIGURE 2 (b)
Fragment showing shrinkage cracks.

Contrasted with the cold-worked crack illustrated in Figure 1, are hot tears or shrinkage cracks which occur while a steel casting is cooling down in a sand mold. Such cracks, branching from a sinus-like cavity, are shown in Figure 2 together with the edge of a fragment showing similar conditions. Both types of defects are undesirable in steel castings and should be prevented. In the first case, the hydrostatic test ruined the casting. In the second case, proper design can eliminate such defects. The exograph reproduced in Figure 2 corresponds to section 3.1 in the ell fitting in Figure 1. By putting some more metal into the fillet, the foundry overcame this difficulty (506). This, by the way, shows how to mark the sections of a casting to identify each exograph. Lead markers are placed opposite the painted numbers seen in Figure 1. These markers appear in the exographs. A more complicated marking system is required when dealing with objects of the size illustrated in Figure 3 where 125 exographs are required to cover the entire casting (255).

When a defect is discovered, it is important to know how seriously it may affect the usefulness of the object. Sometimes it is cheaper to replace the casting, at other times we want to determine the actual location of the defect and possibly repair it. This can be done quickly by means of a double-exposure technique (358). In this, two images are made on one film and between the exposures the X-ray tube is shifted a certain known distance. A mere comparison between the respective displacements of reference markers on the two surfaces of the object and spots in the shadow of the defect will permit an opinion and directions for necessary repairs. Of course, the defect can actually be reconstructed geometrically if desired. To show this on an example from practice, let us consider a large sand pocket which occurred in one of the manifolds illustrated in Figure 3. The double exposure exograph shows that this defect is located close to the outer surface and does not penetrate more than about half way through the wall. It, therefore, is considered permissible.

X-ray inspection is of value not only in the manufacture of steel castings; it also may be applied wherever material is being installed for severe and long-time service. This is indicated by the following

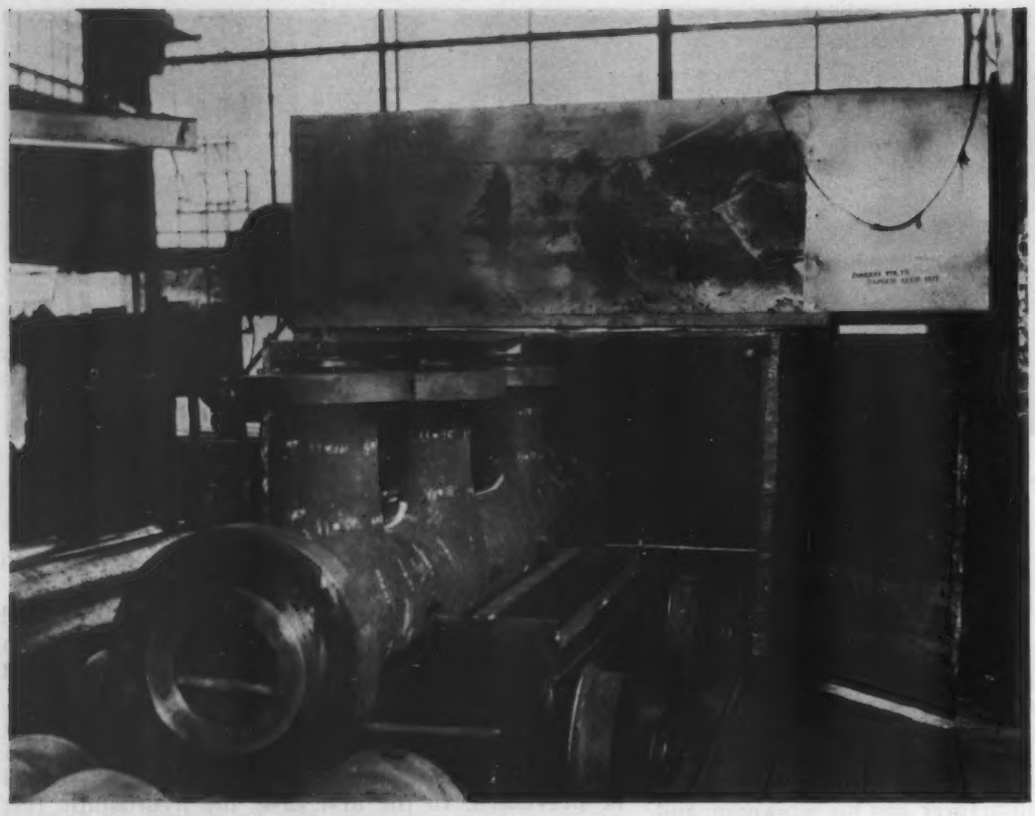


FIGURE 3 (a)

Manifold casting ready for X-ray inspection.

FIGURE 3 (b)
(Below)

Double-exposure exograph showing sand pocket.

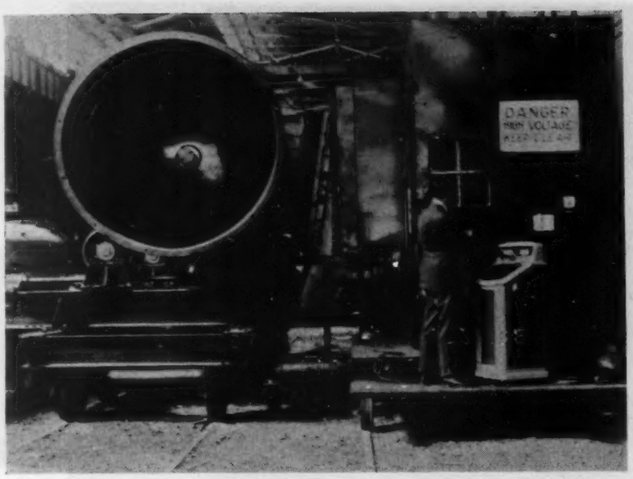


FIGURE 4 (a)
X-ray equipment examining welded seams in a pressure vessel.

of the materials used, and radiography showing the soundness of the individual joints, distrust of welding is removed and it is acceptable for the severest service; for example, the seams in boiler drums or other vessels to be operated at high-pressures and high-temperatures. Recognizing the value of the welding process, the Boiler Code Committee of the American Society of Mechanical Engineers and the American Petroleum Institute, in 1930, sanctioned the use of it in the construction of unfired pressure vessels, and made X-ray examination mandatory for the welds (301). An installation for this work is illustrated in Figure 4 (403).

WITH AND WITHOUT BEADS

At the beginning, many boiler manufacturers objected to this requirement, but some are ardent supporters of radiography since they have learned to appreciate the advantages that it offers.

An exograph like the one shown in Figure 4 (b) cannot be found today any more; it shows slag

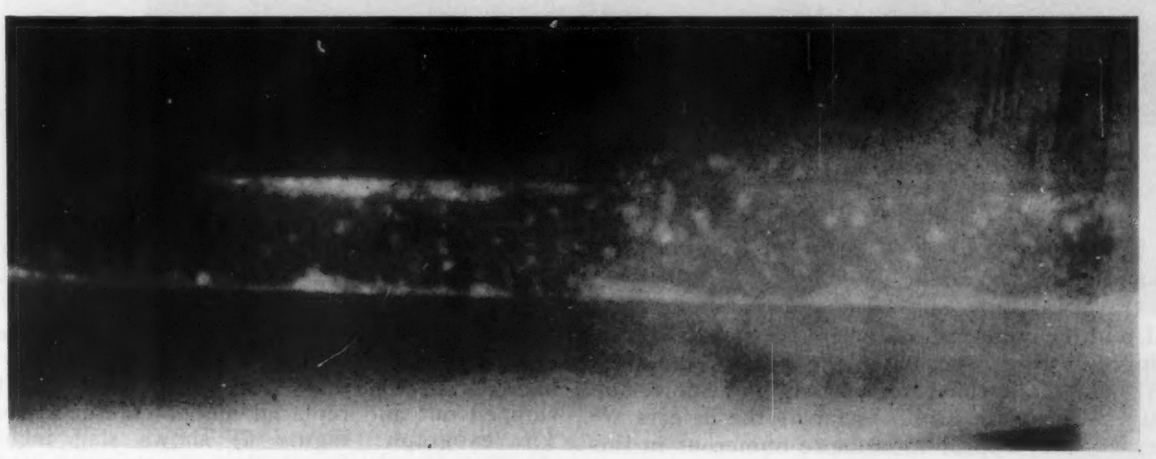


FIGURE 4 (b)
Slag inclusions and porosity in a weld.

example: An American concern bought a large quantity of seamless pipe from a foreign manufacturer, which was accepted by the purchaser's inspector before shipment. Upon arrival in this country, laboratory tests and micrographic study indicated that the pipe had been cast rather than forged. By visual examination of the inside of this 28-inch pipe, laps on the surface were discovered. Subsequent X-ray inspection revealed fine hair-cracks starting from these laps and extending through the wall of the pipe which was only ⅝-inch thick. The entire shipment was rejected and replaced by domestic material (659).

LOOKING INTO WELDS

Today, welding often replaces riveting in refractionating columns, pressure vessels, bubble towers and other refining equipment. When properly made, a welded seam is often stronger than the metal it joins, but because of careless or incompetent workmanship or engineering, a weld which appears on the surface to be excellent actually may be thoroughly bad and unreliable. Experience shows that with chemical and physical tests proving the quality

inclusions along the scarfs and porosity in 2¼-inch plate stock with the excess weld metal removed. While it is not standard practice to remove excess weld metal, it is most desirable in order to find all the small defects which might be present in a weld. The difference between the exograph of a weld with beads and the same after removal of the excess metal is shown in Figure 5. When the beads are present the changes in transparency are well defined between the dark central band where the rays have traversed

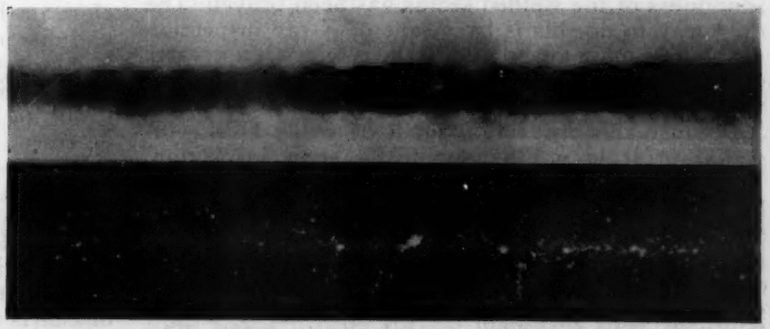


FIGURE 5
Defective weld with and without beads.

FIGURE 6 (b)
Corresponding chip showing slag inclusion.

FIGURE 6 (a)
Defective weld in pressure piping.

both beads as well as the intermediate parts of the weld and plate, two adjacent sections where the rays have traversed only one bead and the underlying metal, and the outer regions where the rays traversed nothing but the plate. After the beads have been milled off, the welded region has the same film density as the plate itself. As far as the defects are concerned, they appear to be more numerous in this case when the beads are removed, since they are of an order less than 2 percent of the total plate thickness and were thus covered up by the excess metal. In some cases, especially in single V-welds, such as employed in piping, it is advisable to make two exposures parallel to each scarf.[b]

Pipe lines which connect pressure vessels, for instance, must be considered part of that system and their fabricating requirements should be similar to those prevailing for the vessels. This is particularly important with increased pressures and temperatures which range now up to 2500 pounds per square inch and 1000° F. as used in modern oil cracking processes. The method of joining pipes by welding can be considered safe for such extreme service only if the soundness of the welded seams has been proven. The only way to do this is by means of X-ray inspection (727). The main advantage to the refinery is a greater output and higher efficiency through the use of welded pipe lines.

Because this inspection must be made at the installation it is not as simple as shop inspection. Besides the conditions under which the work has to be done, the X-ray apparatus has to be more flexible and more rigidly built than shop equipment. To meet these conditions we designed a power plant with a double valve tube arrangement similar to the Zimmermann (38) circuit. The entire generating equipment is oil-immersed inside a single tank (752). The features of this machine were discussed in a recent article in the News Edition of Industrial and Engineering Chemistry, Volume 17, 1939, page 423. An exograph of a defective weld is shown in Figure 6. If welded seams are found seriously defective, they must be repaired. The defective metal, Figure 6 (b), is chipped out and replaced, under careful procedure. The exograph (Figure 6) shows slag inclusions alongside one scarf, which was confirmed after the defect was removed. In another case we discovered a faulty shop weld which was close by the field joint under investigation. While the field job was done perfectly well, the other weld had to be removed in the field and rewelded on the job. This is illustrated in Figure 7.

[b] Chem. & Met. Eng., Vol. 46, 1939, p. 425.

WORKING PROCEDURE

While the compact design and the practically point source of radiation of this new X-ray tube (760) make it possible to work at close distance, this feature, at the same time, limits the area of exposure. The focus-film distance should be about twice as great as the portion of the object under examination. In order to obtain the best results, the film should be close to the object. The image of a defect is enlarged and distorted as the distance between it and the film is increased. This is one of the reasons why a 2 percent marker, for instance, which is located at the inside of an object (nearer to the film) cannot be detected, whereas the 2 percent marker placed on the tube side does show up.

For quick reference and accurate determination, we have constructed special exposure charts (528). These charts take into consideration the actual density of the material in order to determine the exposure factor, and the length of the area under exposure. A group of charts and a table are reproduced in Figure 8. As an example for the correct use of these, solutions are shown of the following problem: "Find the correct

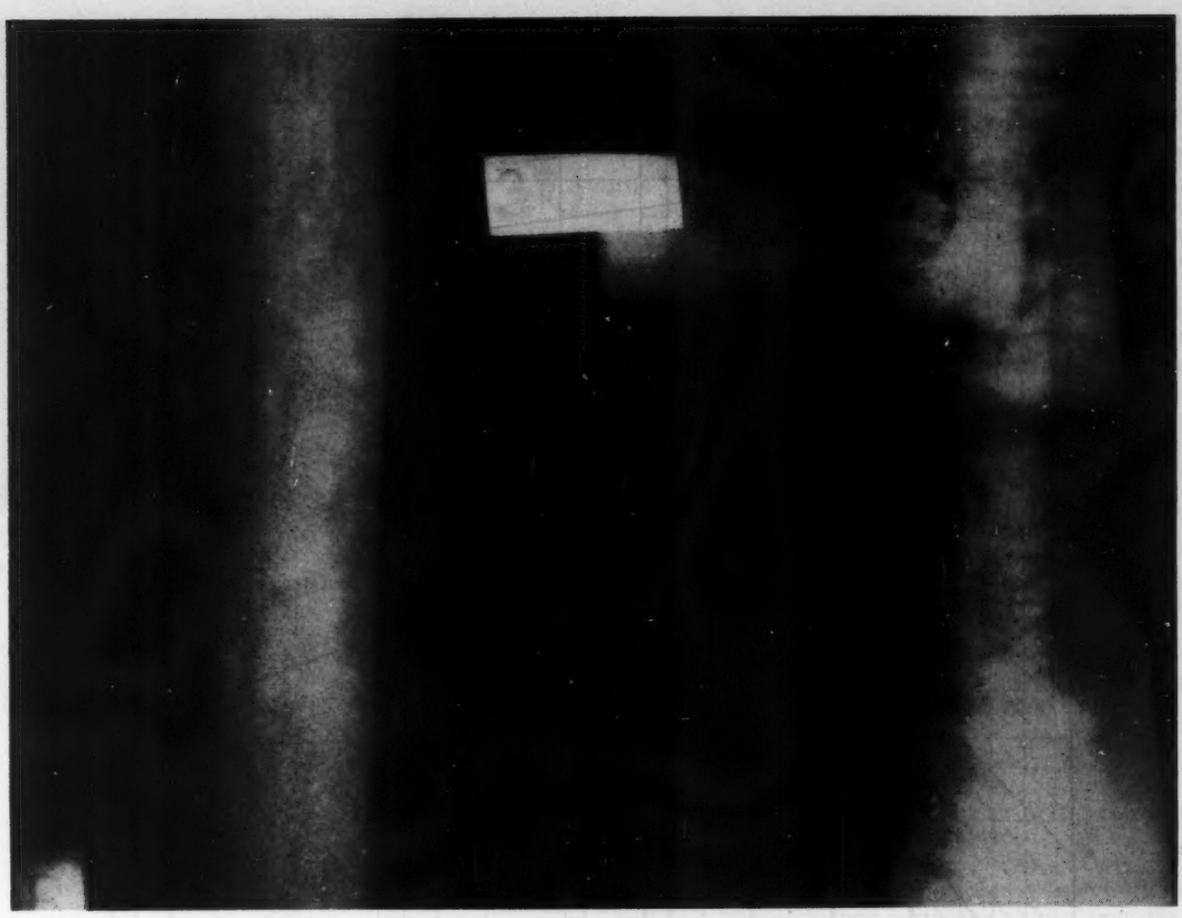


FIGURE 7 (a)
Sound field and defective shop weld.

FIGURE 7 (b)
Chip from shop weld.

exposure on 17-inch film at 36-inch focus-film distance for 3-inch boiler plate of density 7.85 using (a) 220 kv, (b) 300 kv, and (c) 400 kv at 8 ma." To compute the exposure factor at the ends of films of various lengths and at different focus-film distances, the factors shown in the table are multiplied by the actual density of the metal. In this example the factor 1.027 is located in the column for 36-inch focus-film distance in the line for 17-inch film length. Multiply 1.027 by 7.85, the density of the steel to be radiographed, and the exposure factor is 8.1 which remains the same for all three cases.

(a) Find intersection of 8.1 with 3-inch line on Chart I (Point A), project upward to voltage of tube (Point B on 220 kv line on Chart II). Adjust Chart III so that Point C (corresponding to 36-inch focus-film distance and 8 ma.) is opposite Point B, and the exposure time is read on central scale against arrow: 13½ minutes.

When dealing with voltages above 250 kv another factor must be considered: the Compton Effect (110). This is due to secondary radiation or scattering. In practice this scattered radiation must be filtered in order to obtain good definition in the exograph. We have recently developed various filter sets to be used on different metal thicknesses. The addition of such filters necessitates an increase in exposure time which is indicated in the following table:

TABLE I
Exposure Factors
To Compute the Exposure Factor at the End of Films of Various Lengths and at Different Focus-Film Distances, Multiply the Density of the Steel by the Following Constants:

Length of Film, Inches	FOCUS-FILM DISTANCE				
	12	24	28	36	48
6	1.031	1.008	1.006	1.003	1.000
8	1.054	1.014	1.010	1.006	1.000
10	.....	1.022	1.016	1.009	1.000
11	.....	1.028	1.019	1.011	1.000
12	.....	1.031	1.023	1.014	1.004
14	.....	1.042	1.031	1.019	1.006
17	.....	1.061	1.045	1.027	1.011
24	.....	.....	.....	1.053	1.025
30	.....	.....	.....	.....	1.043
36	.....	.....	.....	.....	1.066

TABLE II
To Increase Exposure Time With Filters Above 250 KV

1½"–2"	2"–3"	3"–4"	Above 4" of Steel
10 percent	20 percent	40 percent	50 percent

(b) In projecting Point A upward, we find Point D at the intersection with the 300 kv line. We now adjust Chart III so that Point C is opposite D, and find the exposure time without filter to be 3½ minutes. Using a filter for 2-3 inches of steel, we must increase our time 20 percent, that is, use 300 kv for 4¼ minutes.

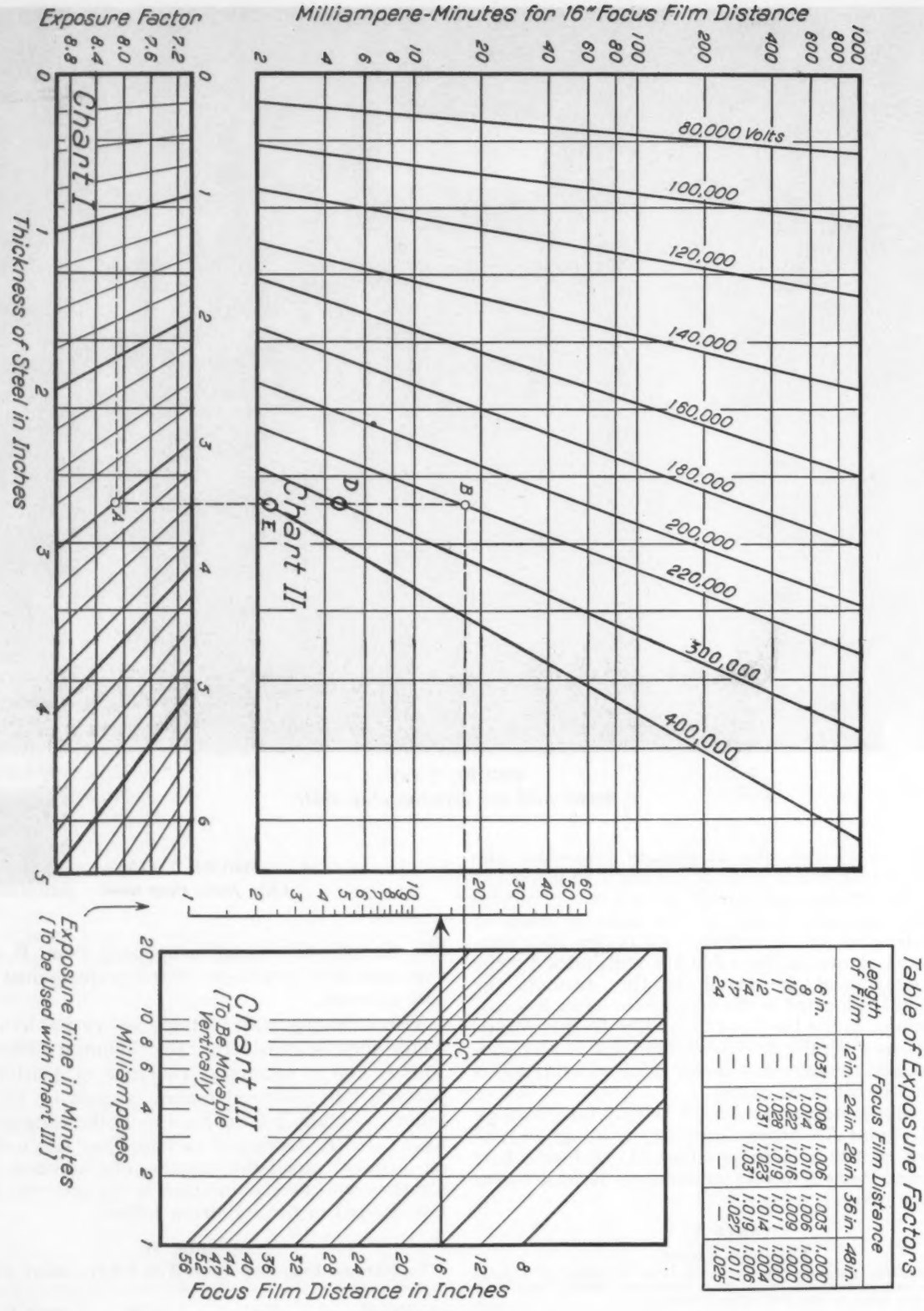


FIGURE 8
Exposure charts for steel.

(c) The same example at 400 kv requires a 2-minute exposure, using the 2-3-inch filter.

While the result with 300 kv at 4¼ minutes would be the same as the one obtainable with 220 kv at 13½ minutes, the result with the 400 kv would not be as good unless we use the 3-4-inch filter at 2½ minutes since the scattering increases with the voltage. For equal results, the following table represents the exposure conditions for three-inch boiler plate:

These results may be contrasted with 1-minute exposure time for the same thickness of steel of 7.6 density at 220 kv and 8 ma but only 16-inch focus-

FIGURE 9 (a)
Ready to X-ray field welded pipe joint.

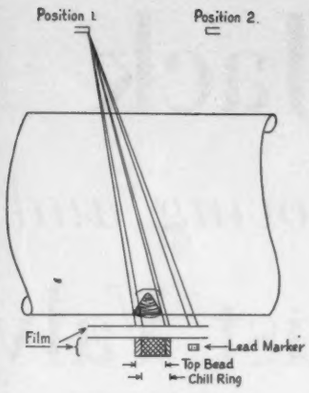


FIGURE 9 (b)
Diagram showing exposure technique.

film distance and 8-inch film. These factors do not make as great a difference on thicknesses below 2 inches of steel, but above 3 inches they are quite important and should be observed carefully.

TABLE III

KV	Minutes	Filter
220	13½	None
300	4¼	2″—3″
400	2½	3″—4″

All other conditions the same.

FOR FIELD TECHNIQUE

A special exposure technique has been developed for field inspection of welded pipe joints (747) where it is hardly ever possible to place the film holder at the inside of the pipe. It is, therefore, necessary to penetrate both walls of the pipe. Figure 9 depicts this exposure arrangement. Lead identification markers are held in place by means of adhesive tape. The tube is seen on one side of the pipe and a leadbox containing the film holder is fastened to the opposite side of the joint. The double-coated X-ray film itself is placed between a pair of industrial intensifying screens which are mounted inside a flexible film holder, illustrated in Figure 10. These holders are inexpensive to make, and a sufficient number of them should be kept on hand to permit fast and uninterrupted routine inspection. They can be made in any desired size and if necessary a set of filters are mounted in the holders with the screens. This depends upon the diameter and thickness of the pipe. After the holder has been loaded and folded in the darkroom, it is placed between two bakelite sheets in a vice and tied together so that the screens make perfect contact with the film. This film holder or cassette must be surrounded by lead to absorb all primary rays and to prevent secondary scattering from striking the film.

The X-ray tube is rotated around the pipe to cover the various sections. A 12-inch diameter pipe is thus divided into 6 sections, and each section is X-rayed from two different angles. In each case the central beam comes approximately parallel to the bevel of the scarf. In this arrangement we eliminate the part of the welded seam toward the X-ray tube from the resulting exograph and only observe the conditions inside the portion of the weld next to the film as can be seen from the diagram with Figure 9.

The chief advantage of welded pipe lines to flanged construction is greater economy in service and less upkeep cost. With X-ray inspected seams greater safety is assured. Frequently, equipment which gave long-time service is supposed to be replaced by new installations. If the material is shown to be perfectly sound under X-ray scrutiny, refiners will find it possible to get many more years of useful service out of it before it has to be replaced.

Two typical cases may be of interest in this connection. In the first instance the inspector found signs of a serious crack on the surface of a large casting. The casting was taken out of service and the crack chipped out. It was thus found that the defect did not penetrate more than about ½ inch and was about 12 inches long. Subsequent X-ray examination proved that all defective metal had been removed and that the remaining material was in good condition. The casting was then repaired by careful welding and put back into service within a few days. In that way an expensive casting was saved and several weeks delay for a replacement were avoided. In another case where the inspector discovered a leakage while the casting was in service, X-rays showed a seriously defective area which did not warrant any repairs. This casting was defective before it was installed. There is no excuse for such material. With proper pilot casting inspection (611) sound metal can readily be obtained. Many more years of satisfactory service are the result.

These examples are but a few cases from a vast and ever increasing variety of applications where X-ray inspection can be used successfully. It would not be fair to close this discussion without sounding a word of warning to those who have not had much experience with this inspection tool. In the highly technical field of X-ray inspection, it is of paramount importance to have the correct equipment available and to be able to call on some one with sufficient knowledge and experience to interpret the results correctly. Otherwise, the work may be misleading and worse than if no inspection whatever would have been made. But when applied properly, X-rays offer a means to prove beyond any doubt the soundness of the material.

Pneumatic Jack

for Removing and Replacing

Exhaust Valve Cages

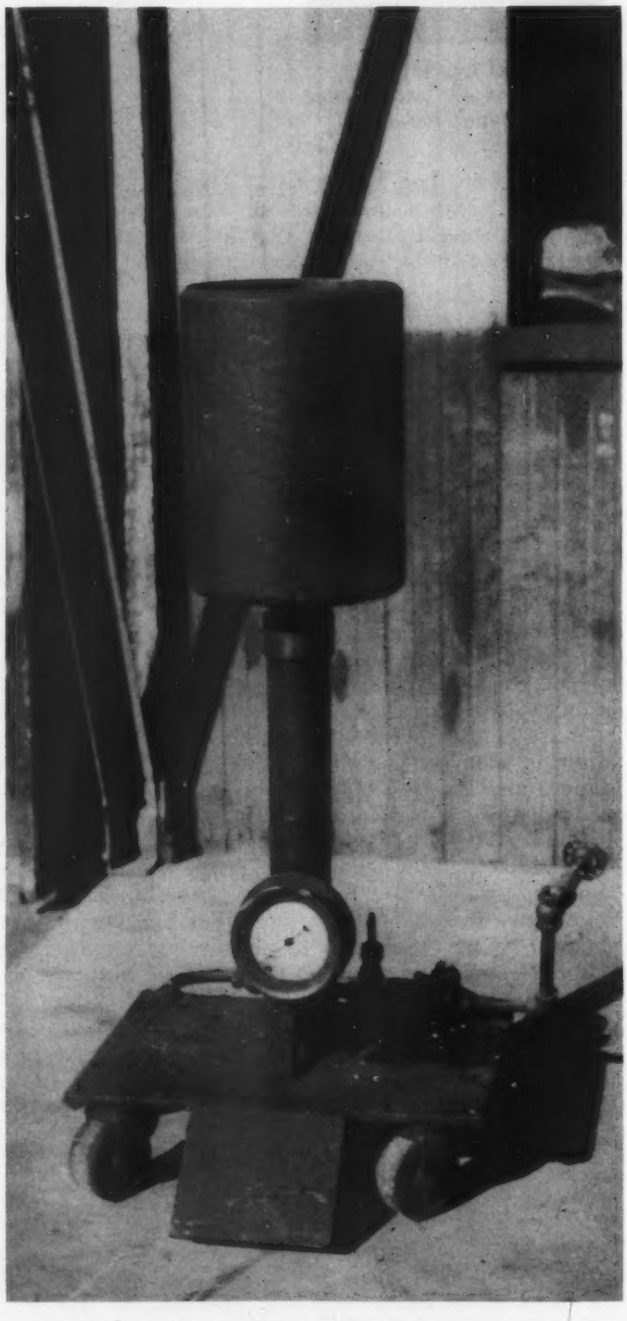
REMOVAL and replacing valve cages on large, double-acting tandem gas engine-driven compressor has been simplified with an apparatus devised by mechanics in a gasoline plant at Santa Fe Springs, California. Prior to the development of this apparatus, mechanics and helpers when repairing these engines used pry-bars to lower the cages as bolts were removed.

The pneumatic jack was developed and made after considerable experimentation to determine just what would be most usable. It is a pneumatic tube, operated in a manner similar to an automobile lift. The base plate is a square piece of steel, mounted on casters with a tongue welded on the front side to facilitate tilting. A short section of a 2-inch pump working barrel is used for the pneumatic tube, welded securely to the base plate and closed at the lower end with a cap. Power and air release piping are attached to the lower end of the tube, and equipped with ¼-inch gate valves for controls.

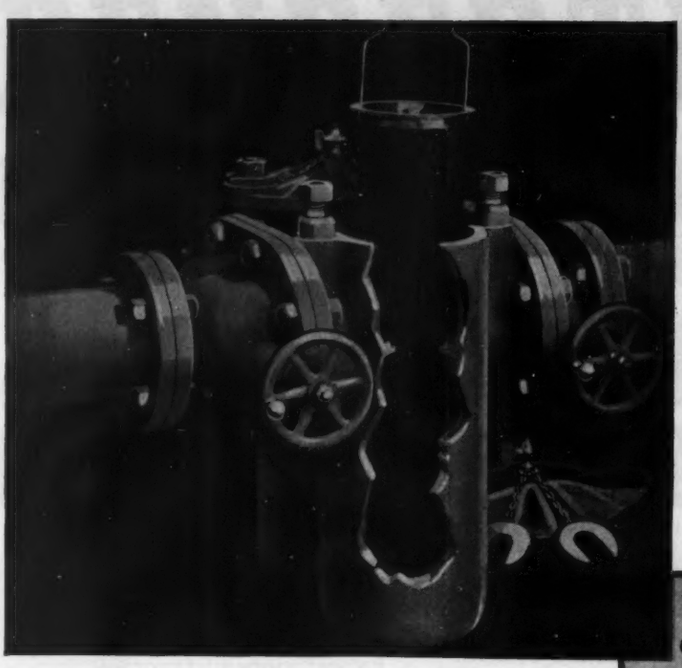
The cage barrel, or receiver for the valve assembly being removed from the engine is a piece of pipe having the proper diameter and long enough to allow the spring and smaller parts to pass into the barrel so it rests against the flanged parts of cage when lifting it in position, or relieving the weight when removing it for adjustment and repair. The plunger of the pneumatic tube is made from a bar of steel, machined and polished for a close, slip fit in the tube and equipped with an ordinary cup such as used in pumping oil wells.

When using this tool, it is placed under the valve and air turned into the pneumatic cylinder until sufficient pressure is obtained to relieve strain on the nuts of the stud-bolts holding the cage in place. After the nuts have been removed, the air is released from the cylinder at a rate which prevents shock of falling. By the aid of the tongue, the entire apparatus and valve cage is tilted outward from the engine where the cage may be easily lifted to the engine room floor for repair.

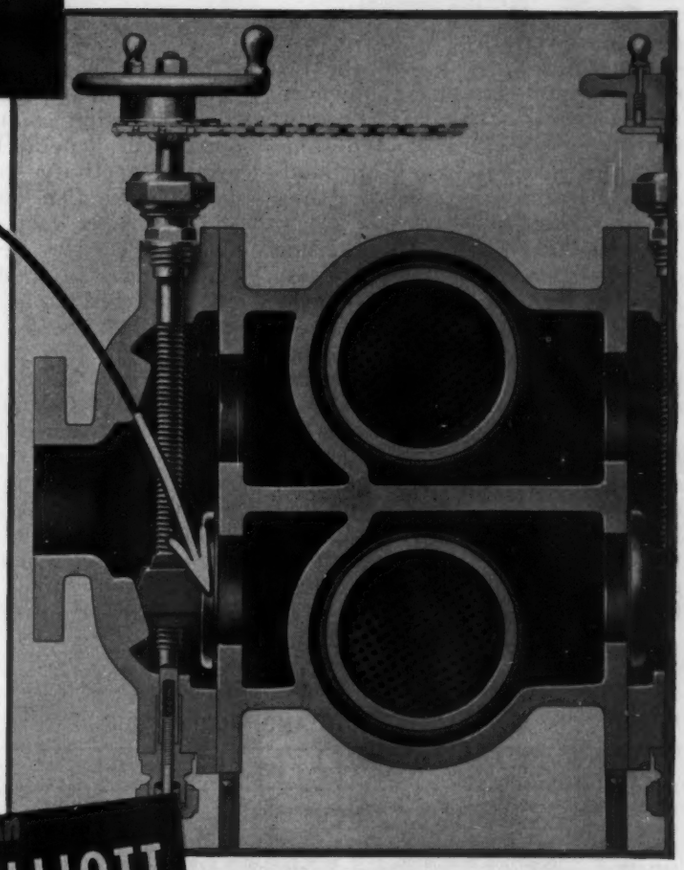
When replacing the cage, it is slipped into the receiver and tilted in position, which may be adjusted by moving the tool on the casters, and air again turned into the pneumatic cylinder to push the cage in place, with gaskets unharmed. Air tubing is connected to service piping to supply power which may be easily controlled with the valve at the base of the hoist. The tool is simple in operation, containing only one moving part; the plunger post, and with liberal lubrication, contains operating air without leakage by expansion of the cup at the lower end of the plunger shaft.



Pneumatic jack for removing exhaust valves and cages from double acting, tandem gas engines.



TWIN OIL STRAINERS keep out all kinds of trouble in oil lines



The sliding gate cleans its own seat

Operation of a gate valve shifts oil flow from the fouled strainer basket to its twin. This valve must be immune to imperfect closing due to particles of foreign matter — and in the Elliott Twin Oil Strainer this factor has been ably met, with a valve disc that brushes off and cleans its own seat just before it is wedged tightly into the closed position by pressure of the traveling nut against the wedge shoes on the inner surface of the casing.

Thus Twin Oil Strainers keep trouble away from *themselves* as well as out of the oil handling equipment which they protect.

This protection is *continuous*. No time-out for cleaning—one basket and chamber always ready to take on the load. Easy cleaning, too — just back off a few nuts, remove the cover, lift out and dump the fouled basket.

Diesels, oil burners, lubricating systems everywhere are being protected by Twin Oil Strainers. Bulletin A-5 tells why. ➡

Built in two types, for 100 and 500 lb. pressures. 11 sizes, from ¾ in. to 10 in. I.D. pipe. Strainer baskets of any desired mesh.

ELLIOTT COMPANY

Accessories Dept.
JEANNETTE, PA.

District Offices in Principal Cities

A-249

Record Demand for Oil Products Indicated for 1940

L. J. LOGAN

THE oil industry's outlook for 1940 is promising, insofar as demand is concerned, as further increases in market requirements for most of the petroleum products are in prospect, following the setting of new records in 1939.

On the supply side of the demand-supply relationship, however, the outlook is only partially bright, inventories of crude oil and some of the refined products being moderate, but those of gasoline being seriously excessive.

Meanwhile, production of crude oil has become somewhat less strictly controlled, and refinery runs have continued at relatively high levels, with the result that gasoline stocks have been growing increasingly burdensome.

Summarizing, the industry is entering the new year with the advantages of good demand for most oils, exceptionally small crude oil inventories, satisfactory stocks of fuel oils, light supplies of lubricants, and generally favorable markets; although it is handicapped at the same time with surplus stocks of gasoline, which threaten to make the year relatively unprofitable as regards the industry's principal product.

Industrial Activity Brisk

Economists are rather generally agreed in the expectation of a further expansion of at least 5 to 10 percent in general industrial and business activity in 1940, which would make 1940 as busy as 1937 and nearly as busy as the banner year 1929. (The Federal Reserve Board index of industrial production averaged about 105 percent of the 1923-1925 level in 1938, as it did in 1936; and some economists expect the index to average about 110 in 1940, as in 1937. The average for 1929 was 119.)

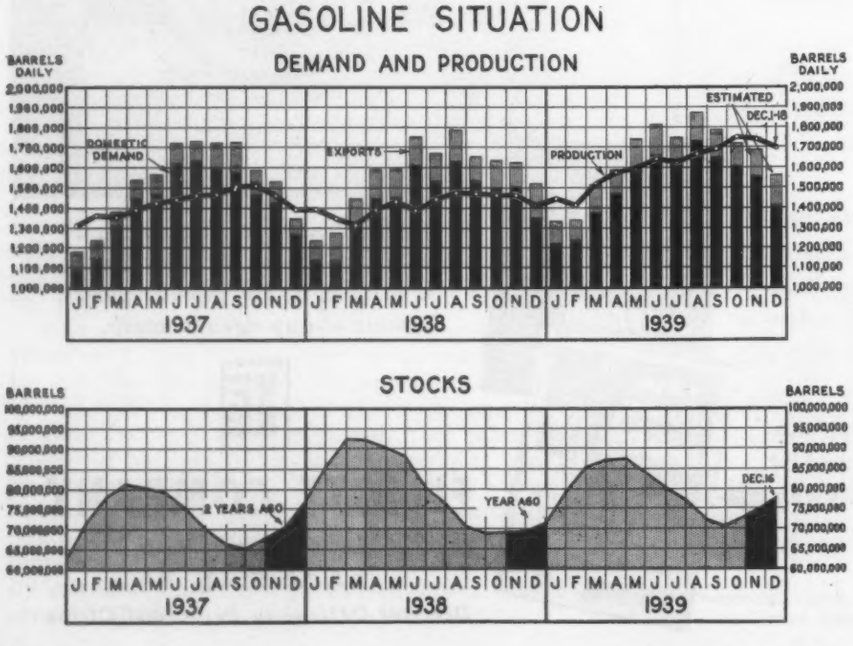
Fulfillment of these optimistic expectations for industry would virtually assure increased volumes of business for oil companies, as the still-growing petroleum industry regularly shows continued expansion in all except particularly adverse years. The industry in 1939 encountered new record demands for its products, including gasoline and fuel oils; and still better records in consumption are in prospect for 1940.

Domestic Prospects Good

Expectations of favorable trends of demand for petroleum products in 1940 are based primarily on the outlook for domestic conditions.

Domestic demand for all oils is expected to be 4 to 6 percent larger in 1940 than in 1939, with fuel oils and lubricants showing somewhat larger gains than gasoline.

Calculations on probable exports in 1940, made by some of the larger oil companies, indicate that shipments may not be materially greater than in 1939, if as large. Some companies, in fact, foresee decreases in export business. The export outlook is clouded and uncertain, at best, because of the wars in Europe, and expectations of foreign business currently are conservative.



Gasoline Outlook

A substantial increase in gasoline demand is indicated by the promising automotive picture. The automobile manufacturers expect to make and sell 10 to 15 percent more cars and trucks in 1940 than in 1939, after having turned out 40 percent more vehicles in 1939 than in 1938. Consequently, a further net gain in automobile registrations is in prospect for 1940, following the setting of new records in 1939. (World registrations in 1939 totaled 45,000,000 motor vehicles, of which 30,710,000, or 68 percent, were in the United States, including 26,250,000 cars and 4,460,000 trucks, according to the Automobile Manufacturers Association.)

Furthermore, there may be expected in 1940 a continuation of the usual increase in annual con-

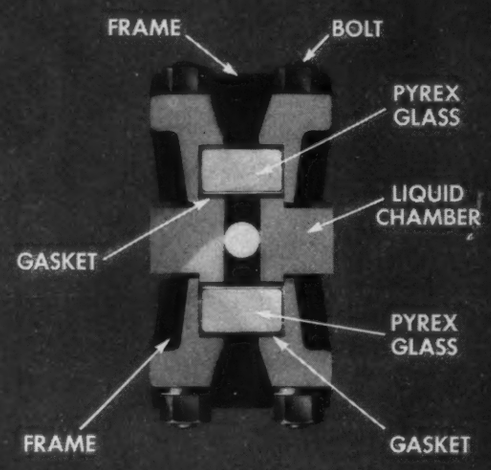
PENBERTHY

DROP FORGED STEEL

TRANSPARENT

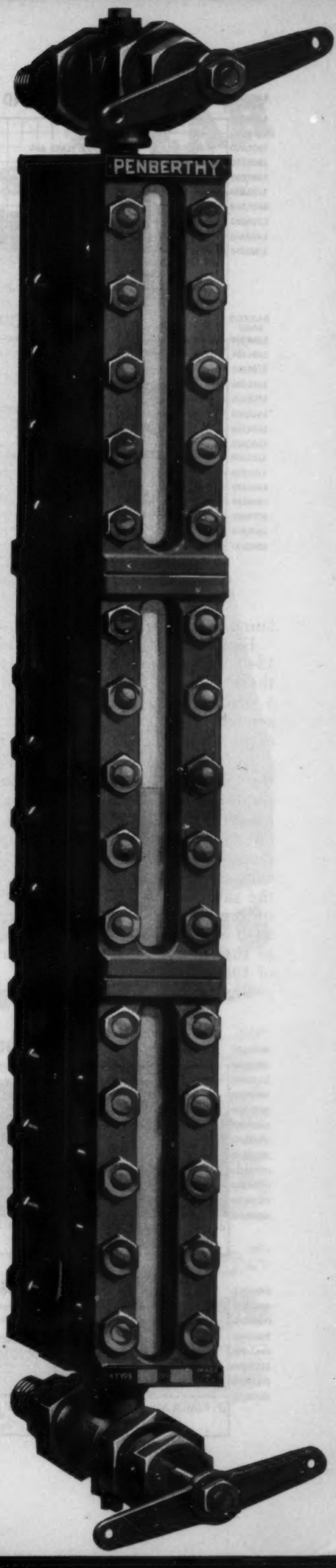
LIQUID LEVEL GAGES

To observe the color or density of liquids under high pressures and/or temperatures



Made of alloy temperature resisting steel. Liquid chamber for single or multiple section gage is made of a solid block of steel the full width of frame to assure perfect alignment and rigidity. Frame has an extra heavy beam at each end and glass chamber is accurately machined to the contour of the glass providing full metal backing for the gaskets. Pyrex glass has greater resistance to thermal shock and erosion.

These gages are available in any length and for various pressures and temperatures. We shall be glad to quote upon your requirements. Write for new Catalog 34-A.

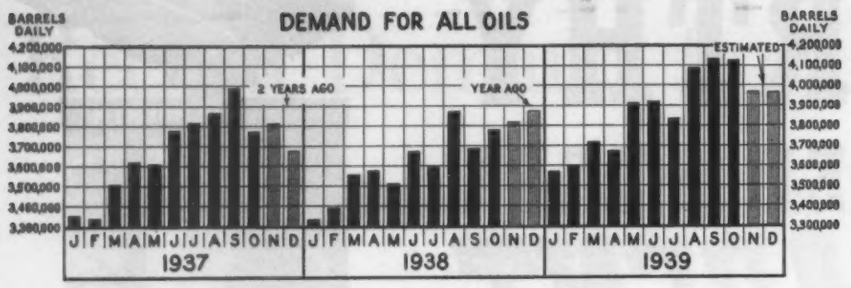


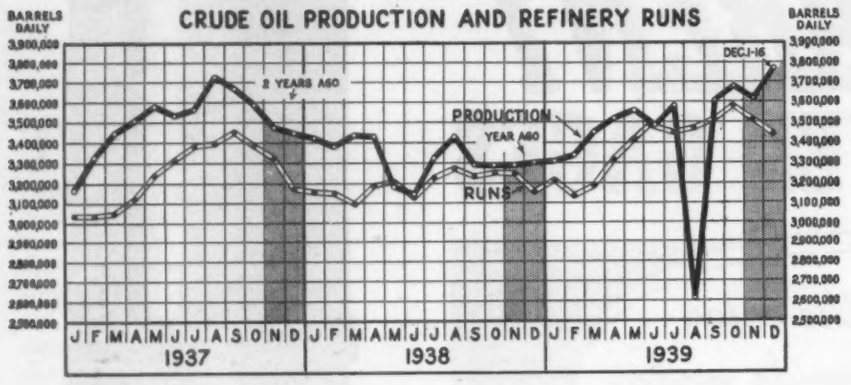
PENBERTHY INJECTOR COMPANY

DETROIT, MICHIGAN

PENBERTHY PRODUCTS

CANADIAN PLANT:
WINDSOR, ONTARIO


DEMAND FOR ALL OILS
BARRELS DAILY
2 YEARS AGO
YEAR AGO
ESTIMATED
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1937
1938
1939


CRUDE OIL PRODUCTION AND REFINERY RUNS
BARRELS DAILY
2 YEARS AGO
PRODUCTION
YEAR AGO
RUNS
DEC. I-16
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1937
1938
1939

sumption of gasoline per vehicle.

Estimates of gasoline demand in 1940 vary somewhat, but most of them indicate an increase of 3 to 5 percent over that in 1939. Consequently, it probably is safe to expect a gain of around 4 percent.

In its forecast for January, 1940, the Bureau of Mines estimated total gasoline demand 4.6 percent greater than in January, 1939, with both domestic and export requirements up approximately that percentage. The bureau also offered at the same time the forecast that requirements in the first quarter of 1940 would be about 5 percent larger than those in the similar period of 1939.

Figures are not yet available on demand for all of 1939, but for the first 10 months of the year, total gasoline demand was 4.8 percent larger in 1939 than in 1938, with domestic use up 5.7 percent and exports down 7.8 percent.

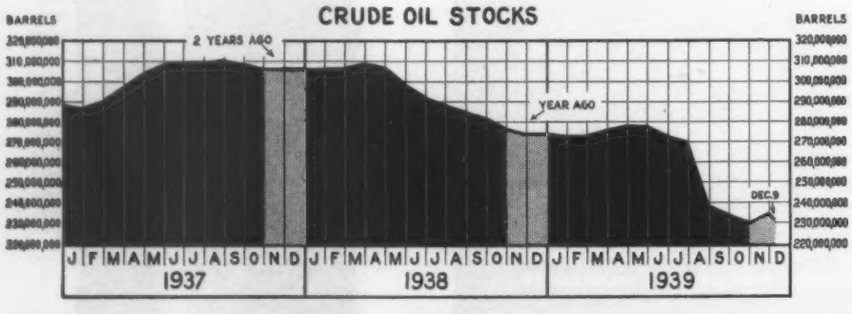
Stocks Embody Surplus

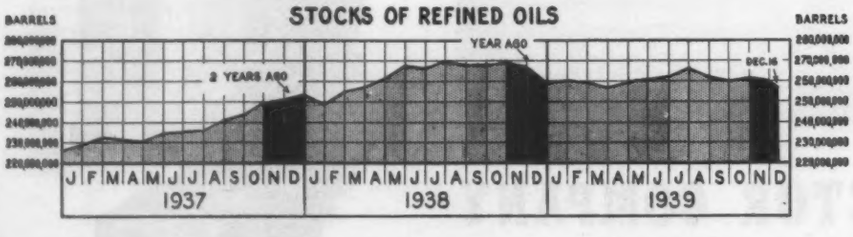
Despite the favorable outlook for demand, however, the gasoline situation is unsatisfactory, stocks being seriously excessive, even in relation to the prevailing large consumption, and prospects for betterment of the inventory position during the coming year being poor.

Despite the repeated warnings offered in the weekly statistics of the industry, gasoline stocks have been permitted to grow increasingly burdensome, until finally they have materially depressed prices, from the refineries to the service stations.

Gasoline stocks in the United States are regarded as 10,000,000 to 15,000,000 barrels larger than necessary, and there is very little likelihood of any cutting down of that surplus through sub-normal additions to stocks during the winter. For relatively large production of gasoline will be necessitated in supplying the prevailing large demand for fuel oil, particularly with fuel oil stocks as small as they are. Even if the winter proves milder than normal, as in the past two years, gasoline stocks probably will be at a new all-time peak and substantially excessive at the beginning of the spring-summer season. And if the winter should be normal or more severe than usual, an exceptionally large and troublesome build-up of gasoline stocks would occur.

The national inventory of finished and unfinished gasoline totaled 80,985,000 barrels on Decem-





Changes from Year Ago in Stocks of Crude and Refined Oils in the United States

(Barrels of 42 U. S. Gallons)

LATEST WEEKLY DATA

(Sources: Crude Stocks, Bureau of Mines; all other figures, American Petroleum Institute.)

STOCKS OF:	Dec. 31, 1938	Dec 30, 1939	Percent Change
Gasoline	71,542,000	80,985,000	+13.2
[1]Gas Oil & Distillate Fuels	28,144,000	26,679,000	— 5.2
[1]Residual Fuel Oil	114,479,000	102,153,000	—11.6
Crude Oil	273,024,000	237,742,000	—12.9

LATEST MONTHLY DATA

(Source: Bureau of Mines)

ITEM	Stocks at End of October		
	1938	1939	Percent Change
Summary—			
Crude Petroleum:			
Refinable in U. S	277,422,000	230,854,000	—16.9
Heavy in Calif	17,143,000	14,070,000	—17.9
Natural Gasoline	6,771,000	5,140,000	—24.1
Refined Products	269,336,000	261,548,000	— 2.9
Total, all oils	570,672,000	511,612,000	—10.4
Days' supply:			
October basis	151	124	—17.9
10 Mo. basis	158	133	—15.8
Products—			
Gasoline:			
Finished	63,542,000	68,116,000	+ 7.2
Unfinished	5,735,000	5,203,000	— 9.3
Total	69,277,000	73,319,000	+ 5.8
Kerosene	9,949,000	9,967,000	+ 0.2
[2]Gas Oil & Distillate Fuels	33,017,000	30,951,000	— 9.3
[2]Residual Fuel Oils	103,423,000	94,757,000	— 8.4
Lubricants	7,718,000	6,639,000	—14.0
Wax (thousands of pounds)	128,926,000	81,147,000	—37.1
Coke (short tons)	653,800,000	652,000,000	— 0.2
Asphalt (short tons)	446,300,000	472,000,000	+ 5.8
Road Oil	686,000	715,000	+ 4.2
Miscellaneous	265,000	289,000	+ 9.1
Other Unfinished Oils	38,816,000	38,765,000	— 0.1

[1] At refineries only, except in California.
[2] At refineries only.

More STRENGTH...Less WEAR

...in PUMP RODS and SHAFTS

...How a strong, corrosion resistant metal hardened by heat treatment stands up in severe service...

EXTRA STRENGTH AND HARDNESS is needed in refinery pump rods and shafts. Other important qualities, too, are desirable. What metal provides them? The answer: "K" Monel.

What makes this metal so good for refinery applications is well illustrated above. In this application the shaft is subjected to a variety of severe conditions. And "K" Monel meets them all. For in this one metal are combined all of the following qualities:

1. High strength, stiffness, and torsional properties for transmitting power without vibration.

2. Hardness to resist abrasion and scoring.

3. Resistance to corrosion and pitting in salt water.

4. Galvanic neutrality when coupled with bronze pump bodies and bearings and cast Monel impellers mounted on the shafts.

5. Low heat transfer between cooling water contacted at one end of the shaft and superheated steam at the other.

6. Good bearing properties with babbitt metal in hot turbines.

7. Low co-efficient of expansion for clearance in babbitt bearings when cold without danger of seizing at high operating heats.

Wherever you need *extra* strength, *extra* toughness and *extra* hardness use "K" Monel. Write for bulletin T-9 "Engineering Properties of 'K' Monel" and C-2 "Monel and Nickel in Oil Refining." Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street
New York, N. Y.

"K" MONEL

"K" Monel is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper, with a small aluminum content that permits hardening by heat treatment.

ber 30, 1939, which was 9,443,000 barrels, or 13.2 percent, more than the 71,542,000 barrels on hand at the end of December a year ago. If this margin above the year-ago trend should extend on until spring, the gasoline stocks would reach a peak of about 97,000,000 barrels as of March 30. Such a quantity would be at least 15,000,000 barrels in excess of needed working stocks, as it is generally agreed that stocks of 81,000,000 or 82,000,000 barrels on March 30 would be quite adequate. The 87,000,000-barrel inventory on hand at the end of March, 1939, was only 7,000,000 barrels above the 80,000,000-barrel supply regarded as economically desirable for that time. Thus gasoline stocks now are and probably will continue to be more seriously excessive than they were last winter.

Demand for heating oil is expected to break all previous records in 1940, after having reached a new high in 1939. The current strong demand is based on the comparatively large number of domestic oil burners in use, and continuation of large consumption is assured by the fact additional burners are being installed in record numbers. Shipments by manufacturers were more numerous in 1939 than in 1937, the previous record year for new installations.

In the first 10 months of 1939, total demand for gas oil and distillate fuel oil was 13.9 percent greater than that in the corresponding months of 1938, with domestic consumption up 14.5 percent and exports 12.8 percent larger.

For 1940, a further increase of at least 6 to 8 percent is anticipated, and in shorter-range forecasts, an even larger gain is foreseen. For the first quarter of 1940, for instance, the Bureau of Mines has predicted an increase of 10 percent in the demand for distillate fuel oils, as compared with the market requirements in the similar period of 1939.

Meanwhile, stocks of gas oil and distillate fuel are light in relation to the prevailing large demand. On December 30 the stocks in the United States were 5.2 percent smaller than a year previously.

The combination of large demand and relatively small inventories naturally has been conducive to a firm market for light fuel oil.

Industrial Fuel Oil

In view of the prospect for brisk industrial activity and relatively large transportation of goods by rail and boat, demand for residual fuel oil, also, is expected to be better in 1940 than in 1939. However, the gain is expected to be somewhat smaller than that for heating oil. The 1940 requirements are conservatively estimated 4 or 5 percent larger than those in 1939. In the first 10 months of 1939, the total demand was 10.8 percent greater than in the similar period of 1938, domestic consumption having been 11.1 percent higher and exports approximately 1 percent larger.

Stocks of the heavy fuel oils, like those of the light oils, are comparatively small, considering the current and prospective large demand. On December 30 the stocks of residual fuel were 11.6 percent smaller than one year previously.

Lubricant Demand Strong

Lubricants are expected to continue in strong demand, because of brisk industrial activity in the United States and the wars abroad. Refiners have had difficulty for several months in supplying demand, and markets have been exceptionally strong. Lubricant demand was 14.1 percent larger in the first 10 months of 1939 than in the similar period of 1938, with domestic use 12.5 percent greater and exports up 18.4 percent. In October, the total demand was 44.4 percent larger than in October, 1938, with domestic requirements 47.1 percent greater and exports up 37.7 percent.

Total stocks of lubricants in the United States on October 31, 1939, aggregated 6,639,000 barrels, or 14 percent less than the 7,718,000 barrels on hand October 31, 1938.

Demand for Oil Better in 1939 Than in 1938

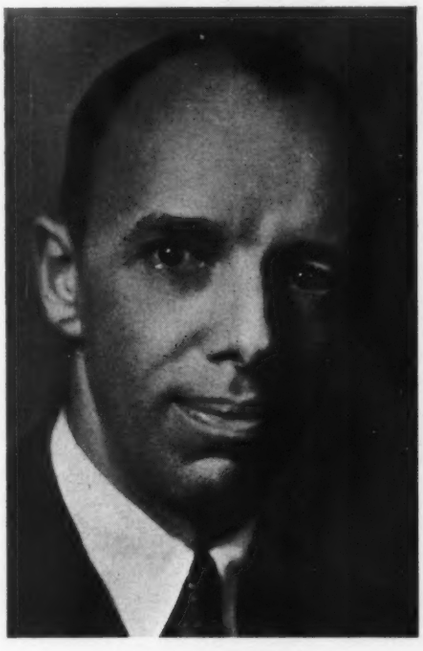
Figures indicate barrels and are from Bureau of Mines

ITEM	OCTOBER 1938	OCTOBER 1939	OCTOBER Percent Change	FIRST 10 MONTHS 1938	FIRST 10 MONTHS 1939	FIRST 10 MONTHS Percent Change
SUMMARY						
Total Demand	117,261,000	128,057,000	+ 9.2	1,096,051,000	1,173,202,000	+ 7.0
Daily average	3,783,000	4,131,000	+ 9.2	3,605,000	3,859,000	+ 7.0
Exports:						
Crude petroleum	6,780,000	6,947,000	+ 2.4	66,769,000	62,094,000	— 7.5
Refined products	9,388,000	9,805,000	+ 4.4	96,779,000	100,536,000	+ 4.1
Domestic Demand:						
Motor Fuel	46,365,000	49,687,000	+ 7.1	436,177,000	461,588,000	+ 5.7
Kerosene	5,185,000	5,019,000	— 3.2	44,179,000	47,865,000	+ 8.3
Gas oil and distillate fuels	10,206,000	11,365,000	+ 11.3	90,204,000	103,222,000	+ 14.4
Residual fuel oils	25,624,000	28,475,000	+ 11.1	234,555,000	260,987,000	+ 11.1
Lubricants	1,805,000	2,656,000	+ 47.1	17,664,000	19,861,000	+ 11.1
Wax	72,000	144,000	+100.0	863,000	863,000	....
Coke	442,000	793,000	+ 79.4	4,563,000	5,864,000	+ 28.5
Asphalt	2,620,000	2,986,000	+ 14.0	21,315,000	23,443,000	+ 9.9
Road oil	695,000	577,000	— 16.9	7,478,000	7,563,000	+ 1.1
Still gas	5,646,000	5,970,000	+ 5.8	55,294,000	55,462,000	+ 0.3
Miscellaneous	149,000	173,000	+ 16.1	1,487,000	1,850,000	+ 24.5
Losses	2,284,000	3,460,000	+ 51.5	18,724,000	22,004,000	+ 17.4
Total domestic demand	101,093,000	111,305,000	+ 10.1	932,503,000	1,010,572,000	+ 8.3
Daily average	3,261,000	3,590,000	+ 10.1	3,067,000	3,324,000	+ 8.3
TOTAL DEMAND FOR PRODUCTS						
Motor Fuel:						
Domestic	46,365,000	49,687,000	+ 7.1	436,177,000	461,588,000	+ 5.7
Exports	4,526,000	3,443,000	— 23.9	40,988,000	38,863,000	— 7.8
Total	50,891,000	53,130,000	+ 4.4	477,165,000	500,451,000	+ 4.8
Kerosene:						
Domestic	5,185,000	5,019,000	— 3.2	44,179,000	47,865,000	+ 8.1
Exports	683,000	1,107,000	+ 62.0	6,377,000	7,024,000	+ 10.2
Total	5,868,000	6,126,000	+ 4.4	50,556,000	54,889,000	+ 8.5
Gas Oil and Distillate Fuels:						
Domestic	10,206,000	11,365,000	+ 11.3	90,204,000	103,222,000	+ 14.5
Exports	1,574,000	2,756,000	+ 75.0	24,958,000	27,907,000	+ 12.8
Total	11,780,000	14,121,000	+ 19.9	115,162,000	131,129,000	+ 13.9
Residual Fuel Oils:						
Domestic	25,624,000	28,475,000	+ 11.1	234,555,000	260,987,000	+ 11.1
Exports	1,643,000	1,296,000	— 21.1	14,913,000	15,054,000	+ 0.9
Total	27,267,000	29,771,000	+ 9.2	249,468,000	276,041,000	+ 10.8
Lubricants:						
Domestic	1,805,000	2,656,000	+ 47.1	17,664,000	19,861,000	+ 12.5
Exports	715,000	985,000	+ 37.7	8,042,000	9,481,000	+ 18.4
Total	2,520,000	3,641,000	+ 44.4	25,706,000	29,342,000	+ 14.1
Wax (thousands of pounds):						
Domestic	20,163,000	40,567,000	+101.1	241,604,000	241,640,000	+ 0.1
Exports	23,529,000	19,210,000	— 18.3	164,069,000	205,689,000	+ 25.0
Total	43,692,000	59,777,000	+ 36.8	405,673,000	447,329,000	+ 10.3
Coke (short tons):						
Domestic	88,300,000	158,500,000	+ 97.9	912,600,000	1,172,800,000	+ 28.3
Exports	27,300,000	22,700,000	— 16.8	119,800,000	234,700,000	+ 96.5
Total	115,600,000	181,200,000	+ 56.7	1,032,400,000	1,407,500,000	+ 36.3
Asphalt (short tons):						
Domestic	476,400,000	543,000,000	+ 14.1	3,875,500,000	4,262,300,000	+ 10.0
Exports	4,400,000	3,500,000	— 20.4	41,100,000	38,000,000	— 7.3
Total	480,800,000	546,500,000	+ 13.6	3,916,600,000	4,300,300,000	+ 9.7
Road Oil:						
Domestic	695,000	577,000	— 16.9	7,478,000	7,563,000	+ 1.1
Miscellaneous:						
Domestic	149,000	173,000	+ 16.1	1,487,000	1,850,000	+ 24.4
Exports	3,000	17,000	+466.6	91,000	91,000	....
Total	152,000	190,000	+ 25.0	1,578,000	1,941,000	+ 23.0

Harts Heads NGAA Committee

H. W. HARTS, general superintendent, Warren Petroleum Corporation, Tulsa, has been appointed chairman of the program committee for the annual meeting of the Natural Gasoline Association of America, which will be held in Tulsa, May 15, 16 and 17. George P. Bunn, association president, made the appointment and the following committee members were announced:

W. F. Fulton, United Gas Pipe Line Company, Houston; J. R. Jarvis, Lone Star Gasoline Company, Dallas; G. W. McCullough, Phillips Petroleum Company, Bartlesville; C. R. Williams, Continental Oil Company, Ponca City; C. M. Wolfe, Standard Oil Company of California, San Francisco; R. A. Worley, Parade Gasoline Company, Inc., Shreveport.



H. W. HARTS

Preliminary plans for the program call for a change from past schedules by which the first session will be held the morning of the first day instead of the afternoon. This will permit more discussion of technical subjects and also allow association members to attend a preview of the International Petroleum Exposition on the afternoon of May 17.

Perkin Medal Awarded

DR. CHARLES M. A. STINE, director of research and vice president of E. I. du Pont de Nemours & Company, was presented the Perkin medal, its thirty-fourth impression, at a joint meeting of the Society of Chemical Industry, American Chemical Society, American Institute of Chemical Engineers, the Electrochemical Society and Societe de Chimie Industrielle January 12 at the Chemists' Club in New York.

The medal is awarded annually for valuable work in applied chemistry.

The Look Box

Patent Suit Settled

DIRECTORS of Chemical Research Corporation have voted to accept the offer of The Pure Oil Company and other members of the patents club to settle the suit brought to recover rights to patents on vapor-phase refining. Previously stockholders granted authority to directors to accept the offer. The settlement will enable Gyro Process Company, 60 percent owned subsidiary of Chemical Research Corporation, to license its cracking process to refiners generally.

The Pure Oil Company and the patents club will pay Gyro Process Company $508,000 in cash and the patents club will cancel a Gyro Process Company debt of $173,000. The Pure Oil Company will return to Chemical Research Corporation its interest in Gyro Process Company, which in turn will give to Standard Oil Company of New Jersey, Standard Oil Company (Indiana), Gulf Refining Company, The Pure Oil Company and The Texas Company the right to various patents without payment of royalty. The Pure Oil Company will grant Gyro Process Company unlimited license to use all patents under litigation, including those covering polymerization as well as free use of improvements that may be developed.

CONVENTIONS

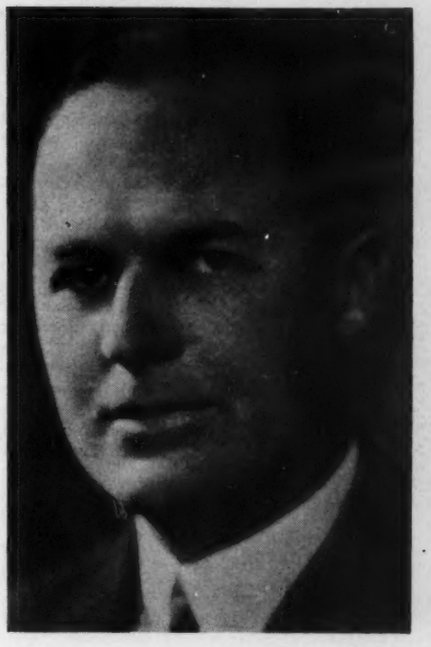
JAN. 15–19	Society of Automotive Engineers, Book-Cadillac Hotel, Detroit.
FEB. 12–15	American Institute of Mining and Metallurgical Engineers, New York.
MAR. 4– 8	American Society for Testing Materials, Statler Hotel, Detroit.
31	Western Petroleum Refiners Association, Allis Hotel, Wichita, Kansas.
APR. 1– 2	Western Petroleum Refiners Association, Allis Hotel, Wichita, Kansas.
8–12	American Chemical Society, Cincinnati, Ohio.
18–19	National Petroleum Association, Semi-Annual Meeting, Cleveland Hotel, Cleveland, Ohio.
MAY 13–15	American Institute of Chemical Engineers, Statler Hotel, Detroit.
15–17	Natural Gasoline Association of America, Hotel Tulsa, Tulsa.
18–25	International Petroleum Exposition, Tulsa.
27–31	American Petroleum Institute, Mid-Year Meeting, Blackstone Hotel, Fort Worth.

Michigan Officials Reelected

ALL officials of the Michigan Oil Refiners Association have been reelected. They are: B. J. Skinner, Mid-West Refining Company, Alma, president; William Davis, Roosevelt Oil Company, vice president; Reid Brazell, Leonard Refineries, Inc., secretary-treasurer; Herman Berg, Alma, executive secretary.

Jones Heads Cities Service Company

W. ALTON JONES, who has been first vice president of the Cities Service Company, was elected president following the death of Henry L. Doherty, founder of the concern, which is the parent company of Cities Service Oil Company.



W. ALTON JONES

Jones went to the New York office of the organization in 1921 as assistant to Frank Frueauff. Previously he was treasurer of Empire District Electric Company at Joplin, Missouri.

January Crude Oil Demand

MARKET demand for petroleum products during January will require a daily average supply of domestic crude oil of 3,569,700 barrels, it was forecast by the Bureau of Mines, December 19.

The January estimate, while 50,000 barrels under the forecast for December (1 percent), is 299,100 barrels above the estimate for January, 1939, and 263,700 barrels (7 percent) above actual output in that month.

In terms of barrels for the month, the bureau stated, 110,660,000 barrels will be required.

Latest figures available to the bureau indicate that daily average crude production during the four weeks from

November 4 to December 2 was 3,624,000 barrels and runs to stills 3,510,000 barrels, while crude stocks increased 2,713,000 barrels and, after deduction of 789,000 barrels of foreign oil, showed a net increase in domestic stocks of 1,924,000 barrels, or 69,000 barrels daily. Accordingly, deduction of the stock increase from the production indicates an apparent demand for domestic crude during the period of 3,555,000 barrels daily, compared with 3,620,000 barrels estimated by the bureau.

"Market trends and estimates indicate a probable increase of about 5 percent in total motor fuel demand and at least a 10 percent gain in distillate fuel-oil demand for the first quarter of 1940, compared with the same period in 1939," the bureau stated.

Gasoline Stocks at Peak

"In recent months large runs to stills at relatively high gasoline yields have resulted in an abnormal seasonal increase in gasoline stocks. Distillate fuel-oil yields have not been increased sufficiently to build up stocks to an adequate seasonal level in proportion to increased demand. Consequently, runs will probably be at a level that will result in at least the usual further increase in gasoline stocks during the first quarter.

"Present indications are that the stocks of finished and unfinished gasoline will approximate new peaks of 80,000,000 barrels on December 31, 1939, and 95,000,000 barrels on March 31, 1940. Any correction of these stock levels will depend primarily on weather conditions and on maximum distillate yields. The bureau's forecast of runs for the first quarter, at about the estimated level for January, is based on the assumption of a possible average distillate yield of about 1 percent higher than the actual for the first quarter of 1939.

"Due to unfavorable exchange and shipping conditions, no large increases in export demand are indicated as yet. As compared to a year ago, exports of lubricants may materially increase and a possible decrease in exports of regular-grade gasoline may be balanced by increased shipments of aviation gasoline."

Discussing the outlook for the coming month, the bureau placed the domestic demand for motor fuel at 39,500,000 barrels, or about 5 percent more than the actual demand in January, 1939. Exports have been estimated as 3,800,000 barrels, 800,000 barrels less than the estimate for the current month, but 160,000 barrels more than the actual last January.

Stocks of finished and unfinished gasoline on October 31 amounted to 73,319,000 barrels, which represented an increase of more than 2,300,000 barrels during October and established a record high for stocks on that date, it was pointed out. Statistics of the American Petroleum Institute indicate a further increase in stocks of 3,250,000 barrels in November, bringing them to about 76,600,000 barrels as of the close of that month.

"These stocks are considerably higher than are necessary and may prove burdensome before the winter is over," the bureau warned. "However, the bureau estimates that finished gasoline stocks will increase 7,300,000 barrels in January, compared with about 7,900,000 barrels in January, 1939."

With benzol and direct sales of natural gasoline estimated at 1,050,000 barrels, a refinery production of 49,550,000 barrels is seen required, which the bureau has distributed among the various districts, as follows:

East Coast, 6,380,000 barrels; Appalachian, 1,910,000 barrels; Indiana-Illinois, 9,030,000 barrels; Oklahoma, 2,890,000 barrels; Kansas-Missouri, 2,470,000 barrels; Inland Texas, 3,630,000 barrels; Texas Gulf Coast, 13,290,000 barrels; Louisiana Gulf Coast, 1,520,000 barrels; Inland Louisiana-Arkansas, 850,000 barrels; Rocky Mountain, 1,280,000 barrels; California, 6,300,000 barrels.

The bureau figured natural gasoline to be blended at the refineries as 7.2 percent of the total gasoline production, or 3,570,000 barrels. The yield of straight-run and cracked gasoline is estimated as 44.1 percent, application of which to the production of 45,980,000 barrels of gasoline gives crude runs of 104,310,000 barrels, or 3,364,800 barrels daily. Foreign crude runs are estimated as 2,300,000 barrels; while exports are placed at 5,750,000 barrels and fuel and losses at 2,900,000 barrels, giving a total demand for domestic crude for January of 110,660,000 barrels, or 3,569,700 barrels daily, which the bureau has allocated among the producing states as shown in the accompanying table.

Estimated Daily Average Crude-Oil Demand by States

(Barrels)

(As no changes in crude-oil stocks are involved in these estimates, they represent demand rather than production)

STATE	Forecast, January, 1940
Texas	1,411,000
California	593,900
Oklahoma	433,900
Illinois	314,800
Louisiana	254,200
Kansas	160,600
New Mexico	101,900
Michigan	61,000
Arkansas	59,700
Wyoming	58,700
Pennsylvania	51,900
Kentucky	12,900
Montana	15,400
New York	13,900
West Virginia	10,000
Ohio	8,100
Indiana	3,900
Colorado	3,900
	3,569,700

Kaye Chairman Refining Committee

EMBY KAYE, manager of recycling operations of Tide Water Associated Oil Company and Seaboard Oil Company, has been named chairman of the refining committee of the International Petroleum Exposition. His committee will direct activities of members of the refining industry who attend the exposition in Tulsa, May 18 to 25.

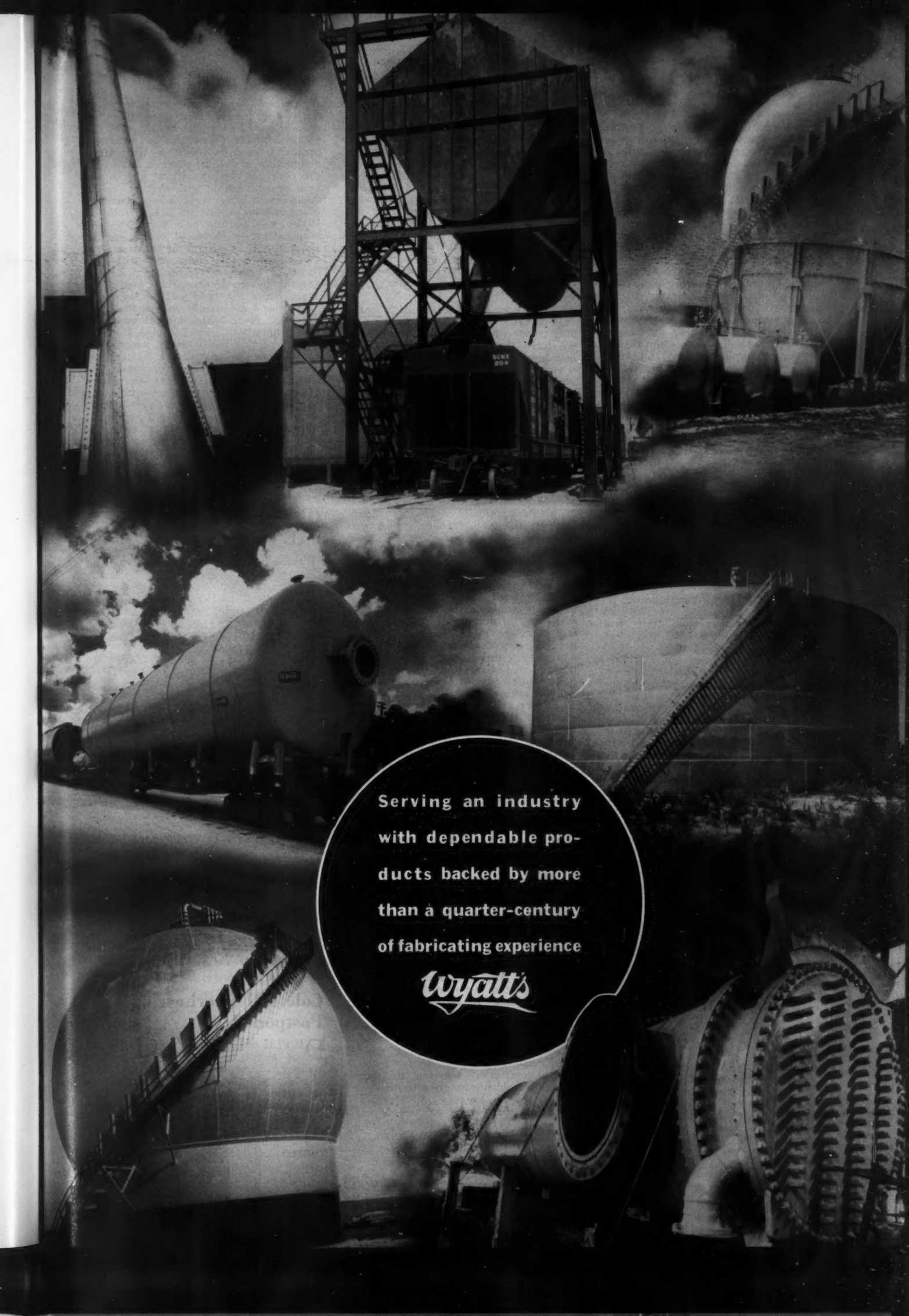
EMBY KAYE

Insight Into Alkylation

HOW the alkylation process came about and where it may lead were parts of the remarks of Frank A. Howard, who in December accepted the award for chemical engineering achievement in behalf of Standard Oil Development Company, of which he is president. The award is made each two years by Chemical and Metallurgical Engineering. The part of his speech of interest to students of alkylation follows:

"Let us now turn to a typical problem of industry and retrace the main lines of attack by which the industry reached its objective. The concrete statement of this particular problem was, that it was necessary to produce a commercial super-fuel of about 100 octane number, suitable for airplane engines. In this case it was a forecast of demand, not competition, which in the first instances presented the problem, and the recognition of this coming demand and its appraisal as serious and permanent was itself an indispensable step which could be taken only on a sufficient background of technical evidence. Economic calculations showed that for a certain small but commercially important amount of business, the aviation consumer would certainly pay a price several times as great as the normal gasoline price for a fuel of 100 octane, because he could get 25 percent increase of power with the same engine weight by taking full advantage of the power possibilities of the 100-octane fuel through higher super-charging; or 15 percent less consumption, if advantage were taken of the fuel solely by raising the compression ratio of the engine. The balance between these maximum power and maximum economy characteristics could be made to meet the service for which the engine was designed. The important thing was that before we could really proceed we had to have sufficient engineering and economic data to show that it was worth spending a great deal of money (perhaps several hundred thousand dollars) in attempting to provide a commercial super-fuel for the aviation industry.

"Making such a fuel was from the outset a chemical engineering problem rather than a straight chemical prob-


Serving an industry
with dependable pro-
ducts backed by more
than a quarter-century
of fabricating experience
Wyatt's

lem because we already had the two basic chemical reactions. These two reactions were the selective polymerization of isobutylene by sulphuric acid from an impure mixture of this gas with other refinery gases, and the hydrogenation of the resulting di-isobutylene to saturate its free bonds and give iso-octane itself. To the first of these reactions we were able to apply the experience of 15 years in the production of alcohols from olefines by absorption in sulphuric acid. For the second operation we were compelled to draw on an entirely separate line of experience and engineering data resulting from our development of the destructive hydrogenation process, applied to mineral oils, by the use of sulphur-immune catalysts. The two operations passed in succession through two stages of laboratory and small-scale development, and emerged as a completely engineered commercial process, operating on a scale of approximately 200 barrels per day. Iso-octane of sufficient purity, in amounts which were small but adequate to develop the business, was available. The initial production cost was high as compared with normal gasoline but it was commercial.

"It was then found that isobutylene could be polymerized or condensed with normal butylene by modification of the acid reaction above described to yield an 8-carbon-atom branch chain unsaturated hydrocarbon which, when hydrogenated, was nearly as good as iso-octane itself, and of lower cost and far greater potential output.

"The latest stage of development was an extremely interesting process, identified perhaps rather indefinitely from the chemical standpoint as 'alkylation.' By this process a low molecular weight branch chain paraffine hydrocarbon is made to unite with a similar olefine to produce directly a saturated branch chain hydrocarbon of the desired molecular weight and volatility characteristics. Through this technique isobutane and butylene unite to form an 8-carbon-atom saturated branch chain hydrocarbon, apparently the same as that which is produced by the polymerization of isobutylene and normal butylene and the hydrogenation of the polymer. The alkylation reaction is already commercially applied to 3, 4 and 5-carbon-atom hydrocarbons. Depending upon the purity of the starting gases, it produces a more or less complex mixture of virtually saturated hydrocarbons of very high octane number. At the present time there are about 15 large commercial alkylation plants in operation or building, with a total production probably between 10,000 and 15,000 barrels a day.

"Up to the time of development of the alkylation reaction, commercial fuels consisted of a base stock which was ordinary high quality aviation gasoline, plus the synthetic blending agents which I have just described (i.e., iso-octane itself, or one of its technical substitutes) plus tetraethyl lead. Usually the base stock made up considerably more than half of the total mixture, so that an accurate description of the super-fuel was that it consisted largely of a normal high quality aviation gasoline, blended with a synthetic hydrocarbon and with tetraethyl lead to raise it to the 'super' level. With the development of the alkylation process the distinction between blending stocks and base stocks has almost vanished. The complex reactions which occur in the alkylation process produce a wide range of hydrocarbons which can very closely approximate the physical composition of ordinary aviation gasoline while still retaining the characteristic of extraordinary resistance to detonation which makes the product a super-fuel. The super-fuel of the present day is still mainly the blended product; but the aviation super-fuel of tomorrow may be almost completely a true synthetic product which has been built up by the chemical combination of simpler hydrocarbons.

"We are so breathless with the progress already made, that few of us are able to see where this road along which we have moved so rapidly over the last few years will lead us. Apparently it is leading us in the direction of converting the natural hydrocarbons of petroleum into simpler compounds of low molecular weight, and then recombining these simpler compounds in new ways to obtain an entirely new molecule having the characteristics that we want, and which we cannot obtain in the natural molecule. This route of development along the lines of true synthesis is, however, paralleled by a companion route which, up to this moment, seems economically much more attractive for the basic products of the oil industry such as motor gasoline. The alternative route is the chemical modification rather than the chemical synthesis route. The earliest and greatest single step in the chemical modification route was of course the process of thermal cracking, by which we now make half of our motor gasoline supply from heavier oils. The hydrogenation process was the next great step forward along this line. It introduced the principle of directed alteration of the natural molecule in place of the brutal decomposition of the thermal process. The force employed to direct the alteration in the hydrogenation operation was the catalyst. No one has yet produced a full equivalent of iso-octane by this alternative route, but tomorrow someone may do it, thus bringing progress on the second and broader economic highway abreast of progress along the true synthetic highway.

"But the synthetic highway has also its own economic reserves. The simplest of all the hydrocarbon building blocks through which hydrocarbon structures might be erected is methane itself—the predominant constituent of natural gas. Few of us realize that the actual tonnage of natural gas reserves in the United States is a very large proportion of the oil reserves, and that the cost per ton of natural gas in the field is comparable with that of oil. At the present time it is much lower in many instances, due to lack of market. When we can find how to utilize methane itself in chemical synthesis, the economic disadvantage of the true synthesis route, as compared with the route of catalytic modification of the natural heavy hydrocarbon, will disappear, and the race will be even.

"Perhaps an insight into the significance of these technological advances would be worth while. I think they indicate the possibility of an automobile engine half the size of the present engine with some increase of power, and with a mileage per gallon twice the present average. Almost certainly, the improvement will be taken up partly in increased power and partly in increased economy, just as has been the case with the airplane engine. These results can be accomplished by small-displacement, high compression, highly supercharged engines, with super-fuels."

EDITOR OF REFINER:

I notice in the November issue of REFINER AND NATURAL GASOLINE MANUFACTURER that I am credited with having read the paper on "High Octane Aviation Fuel by the Sulfuric Acid Alkylation Process."

When the five contributing companies came to consider the presentation of the paper they unanimously agreed that it should be presented by Mr. S. H. McAllister of Shell. Mr. McAllister in a most able manner presented the paper and I am extremely regretful that the credit could not be given to him.

If there is any way this error can be corrected I hope you will do so.

Very truly yours,

K. G. MACKENZIE.

Oil Part of SAE Program

THE place of recent catalytic refining methods as a source of fuel for aircraft engines will be a part of the annual meeting of the Society of Automotive Engineers, Book-Cadillac Hotel, Detroit, January 15 to 19. Other subjects out of the oil industry will be heard during the sessions.

January 15, J. A. Moller, The Pure Oil Company, will discuss "Engine Deposits and the Effect of Some Fuel Additives," on the program devoted to transportation and maintenance.

Catalytic fuels will make up the program on aircraft engines the afternoon of January 16 as follows:

"Availability and Characteristics of Safety Fuels," Robert E. Ellis and W. J. Sweeney, Standard Oil Development Company.

"Alkylation as a Source of Safety Fuels," Dr. Raymond Haskell, The Texas Company.

"Safety Fuels by Catalysis," W. M. Holaday, Socony-Vacuum Oil Company.

The program on passenger cars that evening will have a paper, "Lubricating Oils for Axles and Transmission," by W. S. James, Studebaker Corporation.

"Gasoline Cars and Surveys," by J. B. Macauley, Jr., Chrysler Corporation, will be a part of the program on fuels and lubricants, January 18.

Cole Bill Hearings Postponed

DEATH of Congressman C. E. Mapes of Michigan in New Orleans December 12, brought postponement of hearings on the Cole bill, the federal legislation for regulation of the petroleum industry. It is possible that additional hearings will be held during the present session of Congress.

The sub-committee had invited state conservation officials to New Orleans

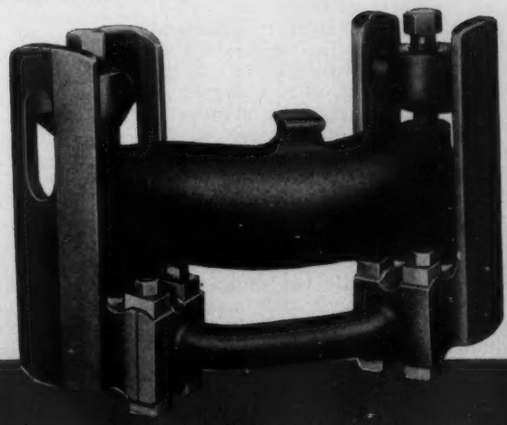
INCREASED DEMAND

PAT'D.

TYPE 2000 OHIO
RETURN BEND

TYPE 1000 OHIO
RETURN BEND

TYPE 2100 OHIO SECTIONAL
JUMP RETURN BEND



PAT'D.

OHIO REFINERY SPECIALTIES . . . Special Fittings of practically any shape or type can be furnished. Alloys of all combinations of Nickel, Chromium and Molybdenum are available for your particular requirements. Ohio facilities have been developed to handle these special requirements as satisfactorily as the more standard designs and specifications.

STEEL FOUNDRY CO.

OHIO • SPRINGFIELD, OHIO

for the sessions, which ended abruptly with the death of the committee member. Only E. O. Thompson, chairman of the Interstate Oil Compact Commission and member of the Texas Railroad Commission, and Jerry Sadler, also a member of the Texas Railroad Commission, had been heard. Both opposed any type of federal control of oil production.

In support of his opposition Thompson gave the following reasons in summary:

"Reserves of oil are being steadily built up.

"The consumer is getting a constantly improved product at a constantly reduced price.

"The states are working in harmony.

"Production is in balance with consumption.

"Overproduction has been stopped and waste is being increasingly prevented.

"I submit that it is better that we get the job of oil conservation done by the states themselves than to further centralize our government in Washington.

"I do not admit that the federal government could do a better job. In fact, I firmly believe the federal government could not do any better job than has been done by the states.

"By granting for the sake of argument only, that it could be a better job, I strongly believe it is far better to stay by the American form of government and keep our control close at home where the people can have a more direct and responsive control over their state resources than to turn them over to some government bureau far removed from the people."

Mexico Feels War Pinch

LOSS of Germany as a buyer has put the Mexican government and its expropriated petroleum industry into decline. Between March 18, 1938, date of expropriation and November 30, 1939, the government shipped 27,978,000 barrels of oil with Germany the leading customer whose takings were 41 percent of the total The United States was second with 26 percent and Italy third with 17.5 percent. No other country had as much as 5 percent of the total.

Now the German market is gone and only Italy is accepting shipments in keeping with figures of the early months of 1939. Influence of this is shown in the following comparison by months of daily shipments from Mexican ports: for July, 81,000 barrels; for August, 66,500 barrels; for September, 37,000 barrels; for October, 46,000 barrels; for November, 39,000 barrels. Mexico uses 64,000 barrels daily in its domestic pursuits.

Since observers of the situation in Mexico are convinced that available storage is full, they look for the petroleum industry in Mexico to settle down to the production of 100,000 barrels daily or less. On this basis the government may be maintaining one of the major industrial activities of the southern republic but the industry on that scale is far from the one which this government took over on the plea that this industry could be better operated for the people of Mexico.

W. P. Gage Promoted

W. P. GAGE has been appointed manager of the development division of the manufacturing department of Shell Oil Company and will have headquarters in St. Louis. For the past two years he has been assistant superintendent of the Shell refinery at Houston, where he also had charge of pilot plants, which played a part in the development of catalytic processes developed and constructed there.

Gage has been in the Shell organization 10 years. After graduation from the University of Oklahoma he went to the Wood River plant. He was in charge of the gas department there when he was transferred to Houston.

Germany's Oil Supply

CONTRARY to many estimates, A. J. V. Underwood in the December, 1939, issue of "Canadian Chemistry" comes to the conclusion that Germany will be able to fill its domestic and military requirements for oil unless the European War changes intensity or some import sources are cut off. The author discusses these sources from crude oil through the synthetic and chemical process, which provide oil and set down 4,300,000 tons as the current total of production.

Stimulation of industry, enlargement of plant facilities and added imports from neighboring countries are due to increase this to 6,550,000 tons by the end of 1940. Consumption figures include Germany, Austria and Czechoslovakia as a single unit. The author gives Polish oil a place in the calculation, since most of these fields are now in Russian hands.

His conclusions after considering all sources are:

"It will be seen that the present rate of production of oil and alternative fuels in Germany is estimated at 4,300,000 tons per year, while the potential rate of production attainable about the end of 1940 is estimated at 6,550,000 tons per year. At a still later date a further increase in production is, of course, possible.

"The oil consumption of Germany, including Czechoslovakia, in 1938 amounted to 7,900,000 tons. The excess of consumption over production must be made up by imports. The sources of imports available to Germany at the present time are Estonia, Rumania and Russia. The Estonian shale oil, which has been imported by Germany for several years, is not large in quantity but has certain properties which render it valuable. The amount available to Germany from this source is approximately 120,000 tons per year, which is likely to increase to 150,000 tons per year with increased production in Estonia. Rumania is an important supplier of oil to Germany. In the first half of 1939 Germany and Czechoslovakia imported 680,000 tons of Rumanian oil, representing 30 percent of Rumania's total exports of 2,230,000 tons during this period. As a result of the trade negotiations, Rumanian oil exports to Germany are to be increased by 5 percent of the exportable surplus. On this basis the amount of Rumanian oil available to Germany will be 800,000 tons in a half year or 1,600,000 tons in a full year. Russia is the world's second largest producer of oil, with an annual production approaching 30,000,000 tons per year, but the amount for export is comparatively limited. It is, however, considered quite probable that Russia could supply 1,000,000 tons of oil per year to Germany without depriving her own industry of its essential supplies.

"With such imports assured from these three countries, which is likely to be the case unless political conditions change greatly, the German resources of home-produced and imported oil would amount to 7,000,000 tons a year at the present time with potential resources as home production is increased of 9,300,000 tons per year. There would also probably be intensified importation of ethyl alcohol and wood distillation products from the Balkan countries but their amounts would not affect the figures materially. The consumption figure of 7,900,000 tons is greater than the present figure of 7,000,000 tons for production plus imports, but substantially less than the potential figure of 9,300,000 tons. The figure of 7,900,000 tons for Germany's 1938 consumption refers to peace-time conditions. The consumption in war time is extremely difficult to estimate as it obviously depends so greatly on the course of military activities. There will undoubtedly be an increased consumption for war purposes, though it must be borne in mind that during 1938 German mobilizations must have meant a considerable consumption of oil.

"Although military activities will result in an increased consumption of oil, there will be a decrease in consumption due to the drastic rationing which has been introduced and due also to the paralysis of German ocean-going shipping. It is known that Germany possesses large reserve stocks of oils and these should be quite sufficient to bridge over the period until the potential productive capacity becomes fully operative.

"It therefore appears improbable that Germany will be rendered unable to carry on the war owing to a shortage of oil unless military activity on a greatly extended scale results in an extremely large increase in consumption or unless the present sources of oil imports into Germany are cut off through changes in the international situation or inability to meet payments required for vital imports or unless Germany's productive facilities are seriously reduced through damage resulting from military operations."

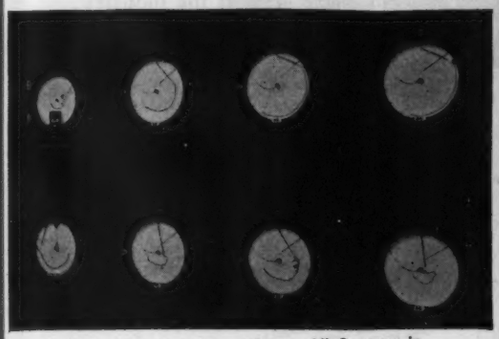
Oil Outlook Off Color

INDUSTRIAL predictions are an expectation with the coming of each New Year. So seldom do business executives fail to build a hopeful prospect that the attitude of some of the leaders within the petroleum industry is singular for 1940. Those who have given their estimates of the year are not as optimistic as are executives in other lines of industry, for the general attitude for 1940 has been hopeful.

Failure of the European War to stimulate export demand is doubtless responsible for the doubt about 1940 in

BROWN INSTRUMENTS
Contribute to the Operation and Control of
HOUDRY UNITS

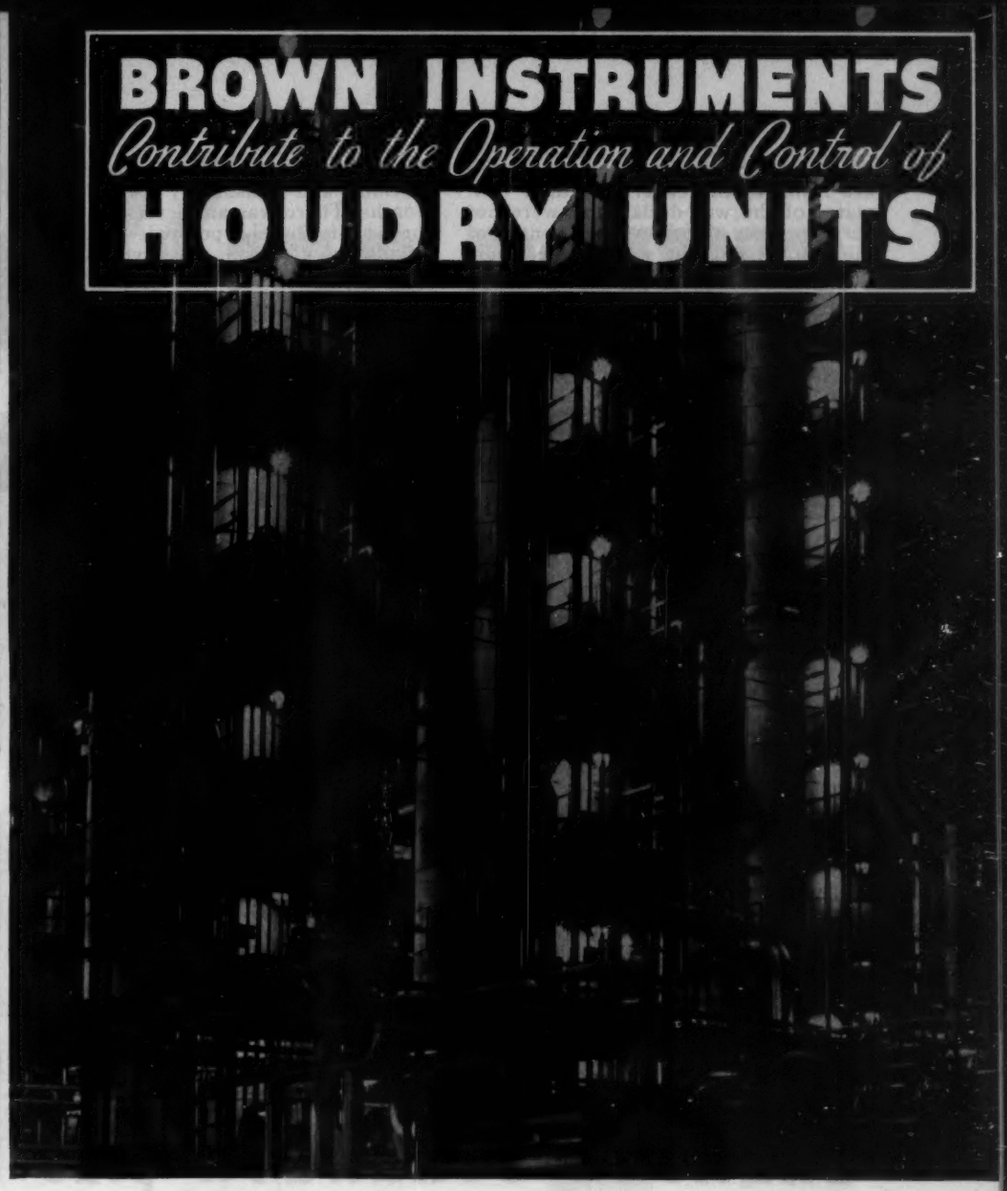
Instrument panel of Sun Oil Company in Eastern Refinery



Instrument panel of Socony-Vacuum Oil Company in Eastern Refinery

Instrument panel of Socony-Vacuum Oil Company in Mid-west Refinery

Instrument panel of Sun Oil Company in Mid-west Refinery



Oil engineers know that accurate measurement and precision control are essential to obtaining maximum yield at lowest cost.

In the operation of the Houdry Units installed at the various refineries of the Sun Oil Company and Socony-Vacuum Oil Company, Brown Recorders and Controllers (shown at left) are giving excellent service and dependable performance in the measurement and control of temperatures, pressures, flows and liquid levels.

Throughout the oil industry, Brown Instruments have won world-wide acceptance on the basis of greater accuracy and dependable performance. Write THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Co., **4498 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street—Amsterdam-C, Holland: Wijdesteeg 4—England: Wadsworth Road, Perivale, Greenford, Middlesex—Stockholm, 16, Sweden: Nybrokajen 7.**

ELECTRIC · AIR OPERATED

ELECTRIC · AIR OPERATED

BROWN INSTRUMENTS

AND MINNEAPOLIS-HONEYWELL CONTROL SYSTEMS

For Temperatures . . . . . Pressures . . . . . Flows . . . . . Liquid Levels

oil. Most statements from oil executives are frank to the effect that their estimates of the war declaration were not correct. Since the first four months of the conflict did not stimulate demand, they hesitate to chart 1940 as bright.

These statements are consistent concerning domestic affairs. They expect an increase in gasoline consumption and in most instances forecast further increase for burning oils.

As examples of what executives think of 1940, parts of the statements of W. S. Farish, president, Standard Oil Company (New Jersey), and Robert H. Colley, president, The Atlantic Refining Company, are being offered. Of the prospect for 1940 and its relation to refining, Farish said:

"It is impossible to review business in 1939 or guess what it will be in 1940, without attempting to appraise the effect of war demands. General expectation of large foreign increase has not been realized. In consequence plans have necessarily been materially changed. Indicative of the uncertainty in planning under today's conditions is the increase in tanker freight rates of over 200 percent since the end of August.

"As the record of petroleum consumption in the World War was phenomenal, it was logical for most of us at this time to expect substantially increased demands. That this has not occurred is due to several reasons. Most important is the limited degree of war activity. Another is the severe restrictions placed on use of oil products in all Europe. Still another is the loss of exports to Germany.

"The total of crude oil and gasoline exported in 1939 was below that in the previous and reasonably peaceful 12 months. There was an increase in sales abroad of Diesel-type fuels and miscellaneous products, but even taking this into account the combined exports showed a reduction last year that was particularly marked in shipments in the last four months from the Gulf and Eastern seaboards.

"At home there was a further gain in gasoline consumption about in keeping with the rise we have been led to expect while the motor car industry continues to sell new units faster than older cars are retired. It is estimated that the United States used about 553,000,000 barrels of gasoline and even subtracting the decrease in exports this meant a gain of 4.8 percent in total demand. However, the increase was not sufficient to prevent an unhealthy addition to domestic stocks. These were 'upped' 8,500,000 barrels and there is at least that much excess gasoline in storage today with crude runs to stills abnormally high."

Ability of the industry to improve its products and lower their prices was among the subjects discussed by Colley, who based his statement on domestic sales and prospects:

"During 1939 the American public was able to consume a record volume of petroleum products at a cost which amounted to nearly $90,000,000 less than it would have had to pay for an equivalent volume in 1938. Once again the industry was able to demonstrate its long established ability to supply increasingly larger volumes of increasingly higher quality products at decreasing costs to the consumer. Total domestic consumption of petroleum products during 1939 was approximately 1,090,000,000 barrels, nearly 8 percent more than in 1938. Present indications are that 1940 domestic demand for petroleum products will exceed that of 1939 by a little more than 6 percent.

"Although the petroleum industry's ability to improve its products while lowering its prices has been due to its relative freedom to conduct its business on the basis of free initiative and free competition, the record of the industry during 1939 was interspersed with illustrations of the trend of legislative thought and action toward uneconomic restrictions and controls. Throughout the year the industry was confronted with a succession of governmental investigations, proposals for the divorcement of its producing and refining divisions from the marketing divisions, proposals for federal control of oil conservation and a long list of proposals for the imposition of discriminatory taxes on the industry's products and facilities."

Estimate 5 Percent Up

ALONG with its estimate of crude oil demand for January, the United States Bureau of Mines indicated that consumption of gasoline will gain 5 percent in the first quarter of 1940 in comparison with the corresponding period of 1939. The gain for fuel oil, light distillate grade, was set at 10 percent for the period.

Office Moved

HEADQUARTERS of Imperial Refining Company will be moved to Grandville, Michigan, where its new plant is being completed. Headquarters have been maintained at the plant at Grand Rapids. The new plant started operation early this year.

Treasury Estimates Oil Tax Gain

GENERAL improvement in economic conditions during the past few months has resulted in an upward revision by the Treasury Department of its estimates or revenues from the gasoline tax for the current fiscal year, it was disclosed January 4 in the annual budget sent to the new session of Congress by President Roosevelt, in which he asked for $460,000,000 in new taxes to defray the expense of his Emergency National Defense Program.

Present estimate of the return from the gasoline tax is $221,600,000, an increase of $11,000,000 over the $210,500,000 estimated a year ago, and the revenue for the fiscal year which begins July 1, next, is calculated at $234,800,000.

Returns from the tax on lubricating oils, however, now are placed at $32,700,000 for the current year, less than the $33,400,000 figured a year ago, but for 1941 they are estimated at $36,300,000. From the pipe line transportation of oil, however, it is now calculated $12,300,000 will be secured, as against an estimate of $11,800,000 a year ago,

GREATER STRENGTH plus GREATER DEPENDABILITY

of DEVLIN HEAVY OIL MALLEABLES . . . your best assurance against future Pipe Line Troubles

DEVLIN ELBOWS and TEES

For 300 pounds Working Steam Pressure and for cold, Non-Shock Working Oil, Water or Gas Pressures as follows: 1" and smaller . . . 2000 lbs.; 1¼" to 2" . . . 1500 lbs.; 2½" to 4" . . . 1000 lbs.; 6" . . . 800 lbs.

Full range of sizes available in Black or Galvanized finish.

FRETZ SEAMLESS NIPPLES

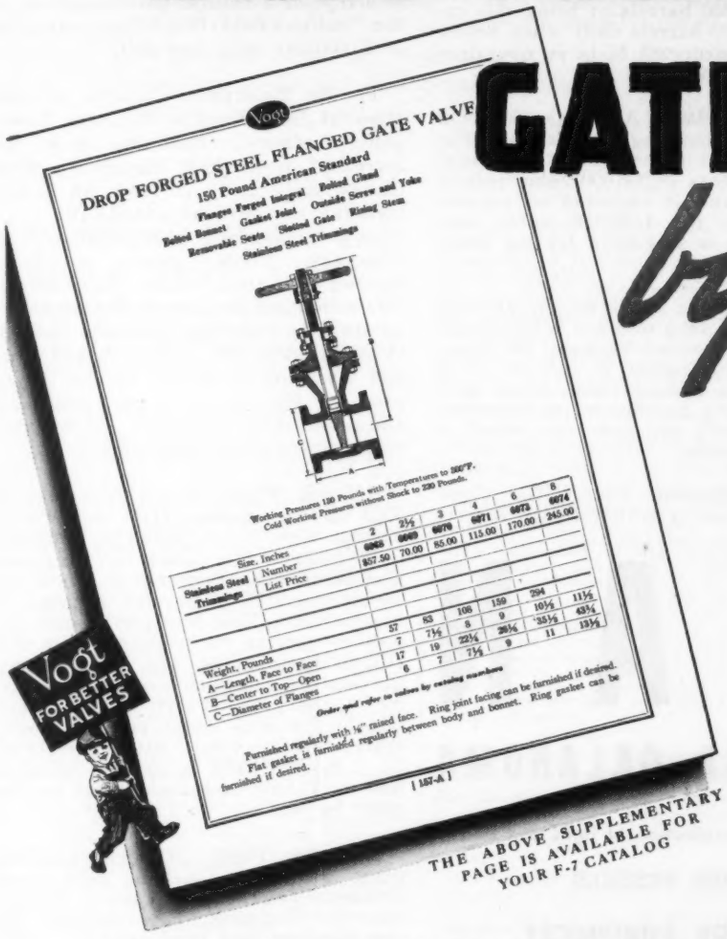
Made from new high quality tested seamless tubing . . . accurately threaded . . . carefully reamed. Standard, Extra heavy, Double Extra heavy, Black or Galvanized. Shipped with Distinctive Devlin Thread Protectors.

Complete stock (including Standard, Malleable and Cast Iron Fittings and Nipples) always carried by J. E. Bobo, 2120 Rothwell St., Houston, Texas, and at the factory.

WRITE FOR CATALOG 15-B

THOMAS DEVLIN MANUFACTURING CO. BURLINGTON, NEW JERSEY

New 150 POUND DROP FORGED STEEL GATE VALVES *by* Vogt


Vogt
DROP FORGED STEEL FLANGED GATE VALVE
150 Pound American Standard
Flanges Forged Integral Bolted Gland
Bolted Bonnet Gasket Joint Outside Screw and Yoke
Renewable Seats Slotted Gate Rising Stem
Stainless Steel Trimmings
Working Pressure 150 Pounds with Temperatures to 550°F.
Cold Working Pressures without Shock to 220 Pounds.
Size, Inches
Stainless Steel Trimmings Number
List Price
Weight, Pounds
A—Length, Face to Face
B—Center to Top—Open
C—Diameter of Flanges
Flat gasket is furnished regularly between body and bonnet. Ring gasket can be furnished if desired.
[157-A]
Vogt FOR BETTER VALVES
THE ABOVE SUPPLEMENTARY PAGE IS AVAILABLE FOR YOUR F-7 CATALOG

VOGT LEADS AGAIN . . . . with a new line of 150 Pound A. S. A. *drop forged* steel gate valves ranging in sizes from 2" to 8" inclusive.

The design features . . (1) Body and bonnet flanges forged integral . . (2) Round bolted bonnet . . (3) Full port opening thru valve . . (4) Drop forged for extra strength and SAFETY.

GET HIGH VALUE for low pressure service . . Use Vogt 150 Pound A. S. A. Gate Valves.

Write for supplementary page 157-A

HENRY VOGT MACHINE CO., INC., LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

and for 1941 the return is expected to be $14,300,000.

In asking that Congress provide $460,000,000 in new taxes, the president in his budget message made no specific recommendations as to how the money should be raised, but expressed the hope that "Congress will follow the accepted principle of good taxation of taxing according to ability to pay and will avoid taxes which decrease consumer buying power."

Lincoln Welding Awards

THE James F. Lincoln Arc Welding Foundation has announced a program of scientific study, which will culminate in awards of $200,000, to be divided into 458 parts. These have been established for studies bringing out benefits of a social, economic or commercial nature.

Participation is open to anyone who plays any part in bringing about progress in the executive, design, fabrication, manufacture, construction or maintenance phase of industrial product or structure development. One author or a group of authors may submit a study. The program will continue from January 1, 1940, to June 1, 1942. Inquiries should be addressed to the secretary of the foundation, Cleveland, Ohio.

The first grand award, $13,700, will be paid for the best progress report submitted. There will be three main program awards of $10,000, $7,500 and $5,000 each. Other awards are by classifications, division and honorable mention, the last of which will receive $100 each.

PLANT ACTIVITIES

Refinery Progressing: Born Engineering Company, Tulsa, and Canadian-Brown Steel Tank Company, Ltd., Brandon, Manitoba, have completed foundation and part of the steel construction at the new refinery located at Regina, Sask. O. B. Males, superintendent at the plant, has been active in the construction and progress being made. The plant will consist of a combination topping unit of 1500 barrels daily capacity and a Dubbs cracking unit with a present capacity of 500 barrels daily allowing expansion for an additional 400 barrels to bring this capacity to 900 barrels daily when necessary. It is expected to be in operation by early spring.

Gasoline Plant: Arkansas Fuel Oil Company is building a natural gasoline plant, the first one in the Waskom field. It will process 20,000,000 cubic feet of gas daily and is expected to recover 300 gallons per 1,000,000 cubic feet. Completion is scheduled for the latter part of January.

Houdry Unit: Work on the Houdry catalytic cracking unit for White Eagle division of Socony-Vacuum Oil Company is being rushed to completion at the Augusta, Kansas, plant. Along with the new unit a gasoline recovery system has been built and new tops added to crude oil tanks.

Gas Purification: Clayco Gas Company has built a Girbotol plan for removing hydrogen sulfide from natural gas in its West Virginia plant. At Sistersville the United Fuel Gas Company has enlarged the capacity of a similar system to take care of 40,000,000 cubic feet daily. Chartiers Oil Company, Wayne, West Virginia, has replaced a former system with a Girbotol unit.

Gasoline Plant: Standard Oil Company of California has started construction of a natural gasoline plant in the Coalinga field. It will have capacity of 20,000,000 cubic feet daily.

To Be Enlarged: Capacity of the plant of Ben Franklin Refining Company, Ardmore, Oklahoma, is to be increased from 4500 barrels to 5000 barrels daily early in 1940. An Ethyl blending unit will be added. The concern is a subsidiary of Bell Oil & Gas Company, Tulsa, whose president, Samuel L. Lubell, visited Ardmore in December and announced the improvements. The plant was formerly that of Wirt Franklin Petroleum Corporation and was shut down for several years prior to 1937 when it was improved and adapted to crude oils of stripper fields of southern Oklahoma.

Refining Plant: Construction of a 5000-barrel refining plant at Tonawanda, New York, north of Buffalo, is scheduled to start in January. The Hambleton Terminal Corporation, which operates 47 service stations in northwestern New York, will build the unit to operate on crude oil from the Illinois basin fields. The site is along the marine terminal already operated by the concern. Recently 34 acres were bought for both plant and additional storage facilities for 140,000 barrels of oil. Crude oil will be shipped by pipe line to Toledo and transported to the plant by water.

Recycling Plant: A third recycling plant for the Grapeland field, near Crockett, Texas, will be built by Grapeland Oil Company. The company has one distillate well producing on a 325-acre lease and plans to drill additional wells.

Topping Plant: Grand Rapids Oil Refining Company will build a 1500-barrel topping plant at Grand Rapids, Michigan. Luke C. Leonard of Detroit is president of the concern. The plant will operate on crude oil from Kent County, where several oil producers are backing the new plant.

J. F. GILMORE COMPANY, 810 South Spring Street, Los Angeles, has been named lower California and Arizona distributor of products of Kropp Forge Company, Chicago.

EDWIN W. ALLEN, vice president of General Electric Company since 1926, died January 1 in Baltimore, where he had been under treatment for two months following an operation.

VULCAN

STEEL TANK CORP. TULSA, OKLAHOMA

Experience and Personnel with the facilities for the manufacture of light and heavy

STEEL PLATE WORK AND PRESSURE VESSELS

GASOLINE PLANT and OIL REFINERY EQUIPMENT

Equipment for Refinery at Spokane, Washington.
ASME Code Construction throughout.
18 Carloads in all.

Composite Catalog Refinery Equipment Page 333

General Office and Plant: N. Harvard and Frisco R.R. ■ P.O. Box 1844 ■ Phone 5-2101

SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

REFINER AND NATURAL GASOLINE MANUFACTURER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

Pressure-Volume-Temperature Relations of Ethylene in the Critical Region, I., J. R. DACEY, R. L. MCINTOSH AND O. MAASS, *Can. J. Res.* **17, B** (1939) pp. 206-13.

Pressure isotherms of the system were determined both above and below the temperature at which the meniscus disappears. Regions of constant pressure with changing volume were observed in the case of all isothermals, as was predicted by Mayer and Harrison. The entire envelope of this region above the critical temperature has not been determined. The pressure of the heterogeneous system at 9.50° corresponded within experimental error to the pressure of the flat portion of the homogeneous isothermal at the same temperature. The pressure of the heterogeneous system was independent of the mass-volume ratio. This finding is in agreement with the experimental behavior previously discovered by the authors for such a system at 9.80°. Also, the pressure of the heterogeneous system was identical with that of the system that had been heated at constant volume to a temperature at which the density difference in the tube was known to have been destroyed, followed by cooling to the same temperature of 9.50°. The isothermal at 9.60° was studied and shown to be the equilibrium curve at that temperature. An hysteresis was observed on reversing the direction of measurement, i.e., from vapor to compressed liquid. This hysteresis was caused by the time lags observed in passing from the vapor region of an isothermal to regions of high density. The observed phenomena are interpreted on the basis of a difference between the gaseous and liquid states of aggregation, with a structure assigned to the liquid state.

Pressure-Volume-Temperature Relations of Ethylene in the Critical Region, II., R. L. MCINTOSH, J. R. DACEY AND O. MAASS, *Can. J. Res.* **17, B** (1939) pp. 241-50.

Data were secured for nine pressure isothermals of the one-component system ethylene in the critical region. Further evidence of the existence of a two-phase system above the temperature at which the meniscus disappears as normally determined is given. Above this temperature a latent heat of vaporization exists. A hysteresis of liquid-phase density with temperature at constant volume is explained, and a qualitative description of the changes occurring in the transition region of liquid to gas is developed from the experimental evidence.

Measurements of Heat Capacity and Heat of Vaporization of Water in the Range 0° to 100°, N. S. OSBORNE, H. F. STIMSON AND D. C. GINNINGS, *J. Res. Natl. Bur. Standards* **23** (1939) pp. 197-260 (Res. Paper No. 1228).

A new series of measurements of the specific heat and heat of vaporization of water in the range 0-100° C. was made in order to determine more accurately the values of the specific heat of water for calorimetric purposes and also to provide more accurate data for the derivation of thermodynamic properties for use in steam tables. Two hundred fifty-six measurements of heat-capacity and 152 measurements of the heat of vaporization were made. The values of the specific heat, enthalpy of both liquid and vapor and specific volume of saturated vapor were determined. The specific heat measurements were compared with values from several important previous investigations.

Thermal Properties of Saturated Water and Steam, N. S. OSBORNE, H. F. STIMSON AND D. C. GINNINGS, *J. Res. Natl. Bur. Standards* **23** (1939) pp. 261-70 (Res. Paper No. 1229).

The completion of new measurements of heat capacity and heat of vaporization of water in the range 0-100° C. has contributed new data that affect the accepted values of the properties of water and steam in equilibrium in the entire range up to the critical region. The results of the entire series of measurements made at the National Bureau of Standards, including the new data, were compiled into a single table of smoothed values covering the properties of saturated steam and water.

The Effect of Compression on the Homogeneous Systems Ethylene and Air-Ethylene in the Critical Region, R. L. MCINTOSH, J. R. DACEY AND O. MAASS, *Can. J. Res.* **17, B** (1939) pp. 231-40.

The effect of compression caused by thermal expansion on the density of the systems C_2H_4 and air-C_2H_4 in the critical region was investigated. Apparently stable heterogeneous systems, as detected through density measurements, are re-formed by this procedure. The significance of the experiments in relation to critical phenomena is considered, and an explanation is given based on a conception of the mutual dispersion of the two phases.

Interfacial Tensions of Some Mercury-Hydrocarbon Oil Systems, F. A. HEDMAN, *Res. Studies State Coll. Wash.* **6** (1938) p. 102.

The interfacial tension against mercury for refined medicinal oils is 366 dynes per centimeter at 25° C. and decreases linearly with rise of temperature: At 125° C. it is 350 dynes per centimeter. For motor oils the interfacial tension is 339-350 dynes per centimeter at 125°, but it decreases irregularly with rise of temperature. The surface tension of some samples is constant or increases between 50° and 75° C., but in all cases it decreases very rapidly above 100° C. At higher temperatures the surface tension for a given motor oil decreases as the period of contact with mercury is prolonged. Motor oils are presumably richer in adsorbable components than medicinal oils, and this may explain the difference in behavior.

A Concrete Comparison of Logarithmic Formulas for Linear Relation of Viscosities and Temperatures, G. JUGE-BOIRARD, *Ann. Combustibles Liquides* **14** (1939) pp. 253-65.

The formula $\log n = \log k + a \log (t + c)$ in which k, a and c are characteristic constants, is proposed, and is shown to be superior to the A.S.T.M. formula for fitting the data from 0° to 110° C. for water, ethyl alcohol, and three widely different oils.

An Absolute System of Viscosity and Viscosity Index, G. HUGEL AND L. CLAIR-BOIS, *Ann. Combustibles Liquides* **14** (1939) pp. 235-52.

The absolute viscosity is found to be given by the expression $n = Ae^{2.303c/(T-b)}$, where $\log A = a$, and b and c are constants to be determined for each case from experimental data. Mathematical analysis of possible viscosity indexes shows that a desirable form of index is given by the expression

$$\sqrt{(C^{0.5} + b)^2 + (C^{0.5} + a)^2}.$$

Chemical Compositions And Reactions

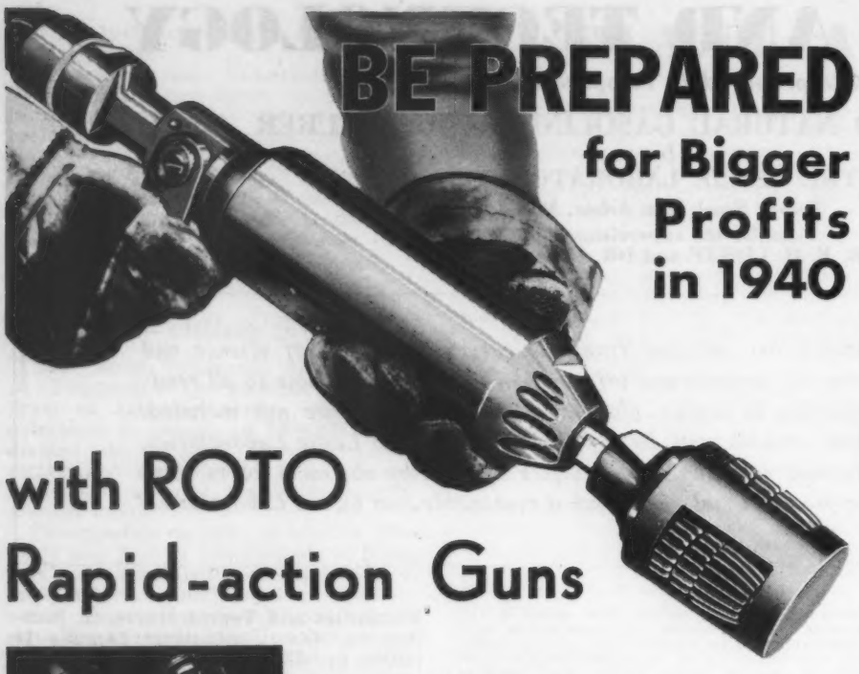
Thermal Decomposition of Ethane Under High Pressure, H. THEILE, *Z. Physik Chem.* **B44** (1939) pp. 41-52.

The thermal decomposition of ethane was studied at pressures between 1 and 10 atmospheres. The data secured substantiate the assuption of a two-body collision for the beginning of the chain reaction. Activation energies of the chain decomposition and the chain part of the hydrogenation of C_2H_6 were obtained experimentally.

Halogenation of Hydrocarbons, J. BURGIN, W. ENGS, H. P. A. GROLL, AND G. HEARNE, *Ind. & Eng. Chem.* **31** (1939) pp. 1413-19.

The chlorine substitution of isobutene has been investigated in detail. It was found to occur rapidly in liquid films and on solid surfaces. By reducing the contact of the hydrogen chloride with the reaction product and by using the excess isobutene, the formation of by-products is reduced to a minimum and good yields of methallyl chloride are obtained. Light causes isobutene to react with chlorine in the vapor phase. This photochemical reaction, in contrast to the liquid-phase or surface reaction, yields saturated dichloride instead of the usual unsaturated chloride, and, like most photochlorination, is inhibited by oxygen. Oxygen has no influence on the substitution reaction. Observations of a similar nature were made with respect to trimethylethylene. The physical properties of the products from the chlorination of isobutene are tabulated. Experiments were made to determine the effect of various conditions upon the reaction. These are reported in 24 separate paragraphs, each dealing with a particular subject. A bibliography of 16 references is included.

Hydrogen Bonding by S-H. VII. Aryl Mercaptans, M. J. COPLEY, C. S.



BE PREPARED for Bigger Profits in 1940 with ROTO Rapid-action Guns

Roto Rapid-action Guns have everything that refinery engineers have sought in tube cleaners. During the past two years, they have helped put equipment back on the line from 10% to 30% (and up to 66%) faster. They can use all the air you've got without back pressure. They develop unbelievable speed and power. A rapid-action air valve, directly behind the motor, enables the operator himself to turn the air on and off instantly, saving precious moments between tubes and eliminating the cost of a helper. A wide selection of self-feeding heads includes cage and swing-frame types, sturdy universal joints and 6-way drills. We can furnish cleaners for straight or curved tubes or pipes from ½" to 18" I.D., operated by air, water or steam.

Be prepared to set new records for speed and economy on your next tube cleaning job with the 1940 Roto Rapid-action Gun. Write or wire for details.

The ROTO Company

145 Sussex Ave. Newark, N. J.

PETROLEUM DICTIONARY

By HOLLIS P. PORTER

A Registered Engineer

This work grew out of a demand for some source of definition for the terms used by the petroleum industry. It contains over 3,000 definitions of words used constantly by all phases of the petroleum industry. It was published in 1936 and has found its way into engineering departments, legal departments and land departments of producing concerns, as well as to the desks of executives of the petroleum industry.

Manufacturers also find it valuable for reference. Advertising agencies find it a valuable addition to the library.

253 PAGES, 6 x 9, CLOTH BOUND, PRICE POSTPAID, $3.00

SEND ORDER TO

THE GULF PUBLISHING CO., P. O. Box 2811, Houston

MARVEL AND E. GINSBERG, *Jour. Amer. Chem. Soc.* **61** (1939) pp. 3161-2.

It has been commonly thought that hydrogen bonding is restricted to hydrogen atoms attached to fluorine, oxygen, or nitrogen. Recently, however, many data have shown that the hydrogen attached to a highly negatively substituted carbon atom will bond to an unshared pair of electrons on an oxygen or a nitrogen atom in an organic molecule. The heats of mixing of n-heptyl and phenyl mercaptans with N,N-dimethylacetamide, ethyl ether, acetone, and benzene were measured. The results afford evidence of hydrogen bonding to donor oxygen and nitrogen atoms by phenyl mercaptan, but not by n-heptyl mercaptan. The failure of aryl mercaptans to show association is a result of the weak donor ability of the sulfur atom for hydrogen bonding and not from any lack of acceptor ability on the part of the hydrogen of the S-H link. Whenever hydrogen is attached to another atom by a sufficiently ionic link, hydrogen bonding is possible.

Manufacture: Processes And Plant

Heat Transfer from Water to a Tube Wall for the Case of Vertical Flow in the Region Between Laminar and Turbulent Flow, A. WATSINGER AND D. G. JOHNSON, *Forsch. Gebiete Ingenieurw,* **10B** (1939) pp. 182-97.

There have been few studies of heat transfer in the critical region. The investigation covers flow in the vertical tubes with some information on flow in horizontal tubes. Work was done using a tube 1 meter long and 50.3 mm. in diameter over a range of Reynold's numbers from 1600 to 10,000. For low Reynold's numbers, Re = 1600, the Nusselt number can be calculated from the equation $Nu = 0.525 (Gr\ Pr)^{0.25}$. For the region Re = 1600 to 4600, the equation $Nu = 0.255\ Gr^{0.25}\ Re^{0.07}\ Pr^{0.37}$ holds; and for Re = 10,000 the usual formulas for turbulent flow hold and were found to be in good agreement with the data from the investigation.

Applied Mathematics in Chemical Engineering, T. K. SHERWOOD AND C. E. REED, First Ed. *Chemical Eng. Series.* 403 pages. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, 1939. Price $4.00.

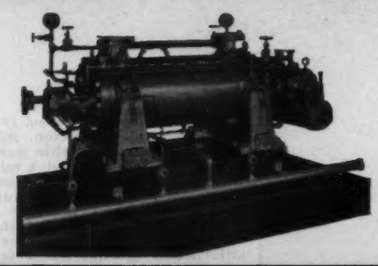
The mathematical treatment of engineering processes involves three basic steps: the expression of the problem in mathematical language, the appropriate mathematical operations, and the interpretation of the results. The book is a valuable exposition of the application of mathematics to chemical engineering problems. The subject matter included a review of the basic calculus, the use of differential equations, the solution of these equations, the application of partial differentiation, infinite series and their use in the solution of differential equations, resumes of methods of fitting data by empirical equations, graphical methods of analysis and representation; the theory of errors and precision of measurement. The context of the book is applied to the solution of stated problems; for example, in discussing the use of differential equations 25 separate problems of a chemical and engineering nature are considered. Many of these are formulated quantitatively and the differential equations formulated. The book is well written, and the context presented in an interesting and forceful manner.

Construction of Manometers for Measuring Flow, A. D. LORING, *Ind. & Eng. Chem.,* Anal, Ed. **11** (1939) pp. 626-8.

The several operations required to make a flow determination with an equal-bore U-tube manometer are reduced to one operation with the direct-reading flow manometer gage described by the author. The instrument is built on the U-tube principle, but one arm is a reservoir with a large horizontal cross section and the other arm is a small-bore glass tube. In using the instrument, the greater external pressure is connected to the reservoir, and the smaller pressure to the tube. A very slight depression of the manometer liquid in the reservoir forces the liquid in the tube to the equilibrium level. In the instrument described, 0.016-inch depression of the reservoir liquid level causes a 30-inch, or full-scale rise in the tube. Methods of marking the scale so that it will read directly in flow are described.

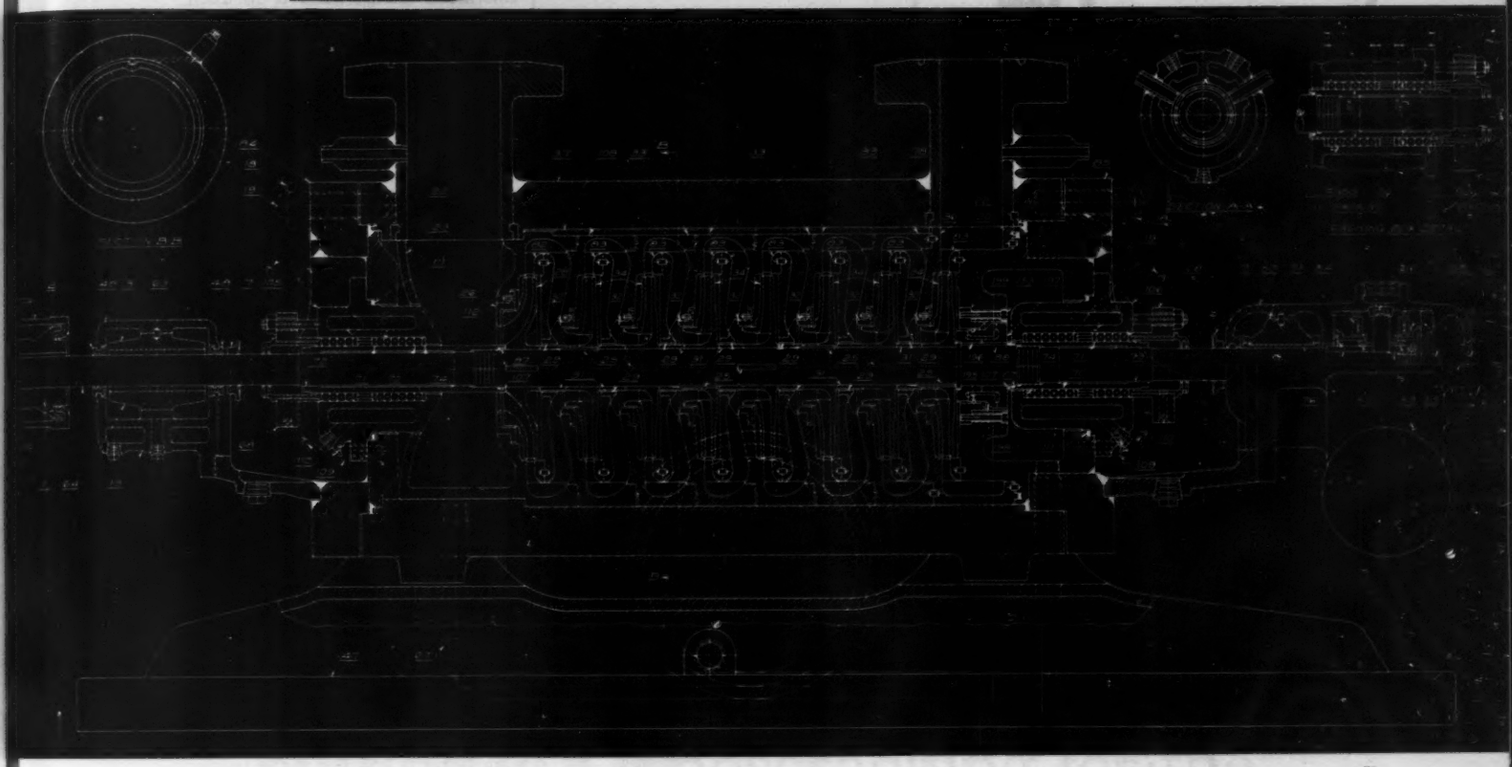
Control of Cooling-Tower Algae with Chlorine Gas, T. C. WALLACE, *Gas* **15** (1939) p. 37.

To remove the algae initially from a cooling tower with a capacity of 40,000 to 50,000 gallons of water, and with a circulating rate of 3000 gallons per minute, a chlorine injection of 1 pound of chlorine per minute may have to continue for 2 hours in order to reach a



"PACIFIC," 4" S., 11-Stage, Type I.M.B. — showing Lube Oil and Water-Cooling Piping — Structural Steel Extended Base.

Experience

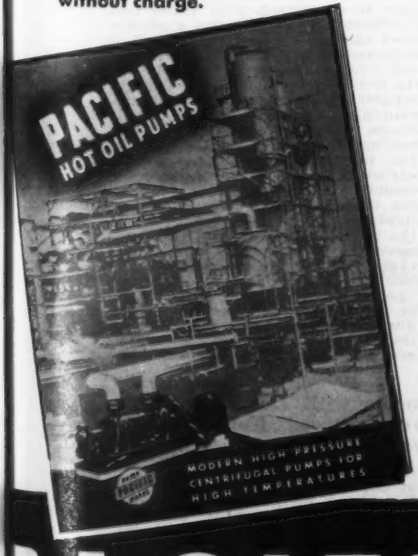


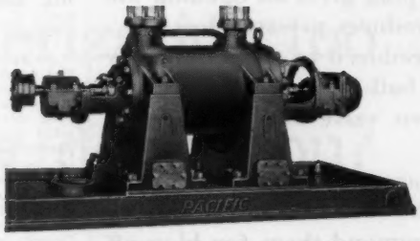
Protected under following United States Patents:

1,986,132	2,007,414	2,108,786
1,990,519	2,087,313	2,161,695

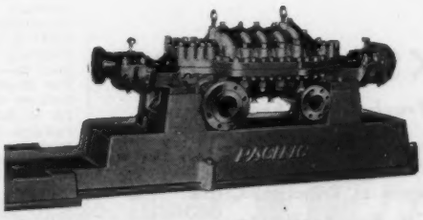
SEND FOR YOUR COPY TODAY

Your name on your Company letterhead will bring you a copy of the valuable "PACIFIC" Bulletin without charge.





2", Type A.M.B., Multi-Stage, Solid Shell, Hot Oil Pump — with Cast Steel Case and Centerline Support — Ball Bearing Mounted.



Type J.H.M.B., Horizontally Split Shell, Multi-Stage Pump for high temperature conditions with Packing Boxes and Outboard Bearings arranged for water-cooling.

"PACIFIC" hot oil PUMP DESIGN OUTSTANDING

Study the assembly drawing of a completely Forged-Steel, Double Case, "PACIFIC," Hot Oil Pump. Here is a design evolved through long experience in building hundreds of pumps to meet difficult high-pressure, high-temperature pumping conditions. Note the engineering and construction features which give "PACIFIC" exclusive claim to distinct advances in Centrifugal Pump development. Illustrated Bulletin No. 74 describes the reasons for the various features of design developed through the years to meet the conditions encountered in this class of work.

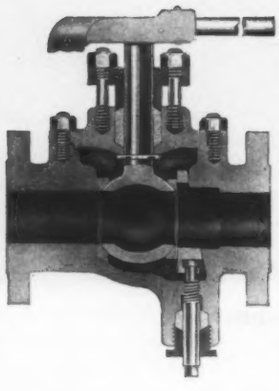
PACIFIC PUMP WORKS

5715 Bicket Street
Huntington Park, Calif.

550 Harding Drive
So. Orange, New Jersey

PACIFIC hot oil PUMPS

They Cut Through Foreign Matter



The shearing action of the rotating ball plug in Sphero Valves cuts through scale or thick viscous materials as it revolves when opening or closing. This, and the perfect seating of the ball, assures a tight, leak-proof seal.

The round portway in the plug gives an opening the same size as in the pipe and reduces pressure loss.

Wear on the seat rings is reduced to a minimum by the rotary movement of the ball because they are not in contact with the flow when valve is wide open or closed.

Fairbanks Sphero Valves are easier and quicker to operate. Working parts can be renewed on the line.

Other features which recommend them for blow-off purposes and services where a full flow, quick-acting valve is required, are explained in catalog No. 21. Write for a copy.

THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

20 E. 4th St. New York, N. Y.

Boston, Pittsburgh—Distributors in Principal Cities

Factories: Binghamton, N. Y. Rome, Ga.

Fairbanks Sphero Valves

chlorine concentration of 10 p.p.m. in order to insure algae destruction. After making 3 or 4 weekly treatments this period will fall to a normal period of about 8 minutes. At intervals it may be necessary to use biweekly treatments for a short period, but ordinarily weekly treatments for 8 minutes at the rate of 1 pound of chlorine per minute will be sufficient. The method for the determination of chlorine in cooling water is discussed.

Waste Problems in the Petroleum Industry, J. B. HILL, *Ind. & Eng. Chem.* **31** (1939) pp. 1361-3.

The paper is one of a group of papers on industrial wastes presented before the Division of Industrial and Engineering Chemistry at the 98th meeting of the American Chemical Society. The petroleum industry has cooperatively studied its pollution problems. Oil in effluent waters is removed by a specially designed gravity separator making use of the principles of low-velocity uniform distribution, film rupture and coalescence, and continuous skimming of oil. It gives effluents containing only 10-15 parts per million of oil. Acid sludges are extensively worked for the recovery of the sulfuric acid in them. Soda sludges from the washing of gasoline must be neutralized and freed from odoriferous compounds before discharge. Hydrogen sulfide recovered from the crude and cracked gases has become an important by-product and is largely converted to sulfuric acid. No oil fractions are wastes, since all have at least a fuel value. The trend is to remove as many of the products as possible from the common fuel class.

Pressure Regulator for Dynamic Gaseous Systems, J. H. BRUUN, *Ind. & Eng. Chem.*, Anal. Ed. **11** (1939) p. 628.

In many instances in which gaseous reactions are studied by the dynamic method it is desirable to maintain pressures higher than atmospheric in the reaction chamber. In order to avoid the disadvantages of using a liquid seal having a hydrostatic head equivalent to the desired pressure, a new pressure regulator was developed. It consists essentially of a glass capillary tube 2.5 mm. in diameter and 85 mm. long and a brass rod 2 mm. in diameter. By means of a micrometer screw the wire may be inserted to any desired extent into the glass capillary, thus increasing the frictional resistance which controls the pressure in the reaction chamber or the system. In order to read the pressure a manometer is attached to the regulator.

Products: Properties And Utilization

Diesel Fuel Characteristics Influencing Engine Output, A. J. BLACKWOOD AND G. H. CLOUD, *Jour. Inst. Pet.* **25** (1939) pp. 684-94.

It appears to be generally recognized that the small high-speed Diesel engine, the rapid development of which has been one of the outstanding engineering accomplishments of the past decade, still lacks the ability to use the wide variety of fuels on which its slow-speed predecessors thrived. The engine manufacturer is faced with the problem of reducing the fuel sensitivity of his high-speed engine so the customer acceptance will not be limited. His problem is serious, because there is no widely standardized pattern for high-speed Diesel fuels such as exists for gasoline. The authors' paper is concerned with those fuel factors that influence power and fuel economy. It is concluded that fuel viscosity as such is not a major factor in the power performance of high-speed Diesel engines, except in instances where worn injection equipment might make it undesirable to use a low-viscosity product. Assuming complete combustion, fuel volatility affects fuel economy only as it is related to heating value and ignition quality. Heating value, in terms of B.t.u. per gallon, may be closely estimated from specific gravity. For most present-day engines having fixed injection timing, ignition quality is a major factor in determining economy in the upper speed ranges. At the lower engine speeds, heat content, as measured by B.t.u. per gallon, is the most important consideration in economy. The principal Diesel-fuel characteristics—viscosity, mid-boiling point, gravity, hydrogen content, heating value, and cetane number—are closely related. If any two of these are known for a given fuel, the others can be closely estimated from a chart such as is presented in the article.

Experiments with Doped Fuels for High-Speed Diesel Engines, J. J. BROEZE AND J. O. HINZE, *Jour. Inst. Pet.* **25** (1939) pp. 657-77.

The use of dopes may be considered to be one of the promising methods for improving the ignition quality of Diesel fuels. Their use may make it possible to meet special require-

Why risk it?

If you got through 1939 without Dubbscracking you are lucky—but why risk it again?

Four refiners are increasing their Dubbscracking capacity as the new year begins—others are putting in Dubbscracking for the first time—and U.O.P. catalytic polymerization too

Why don't you?

Happy New Year

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

AIR SUPPLY
PROPORTIONEERS
for
Continuous Chemical Treatment
"TREATING IN TRANSIT"
Add Color to Gasoline in Exact Proportion to Flow Through Line
1. UNIFORMITY OF PRODUCT ASSURED
Color evenly distributed through entire flow without further mixing.
2. COLOR ECONOMICALLY USED
Treatment in exact proportion to flow prevents waste.
3. ADDITION OF COLOR, METER-CONTROLLED
As shown here, Treet-O-Meter in gasoline line (above), controls Treet-O-Unit pump (below).
4. MICROMETER ADJUSTMENT ASSURES PRECISION TREATING
Easily adjusted screw feed allows close treating over wide range.
Adding color is typical of the many treating and blending jobs which PROPORTIONEERS are now doing—Write for Bulletin TOU-3, address,
% PROPORTIONEERS, INC. %
with BUILDERS IRON FOUNDRY at
31 CODDING STREET
PROVIDENCE, R. I.
REAGENT SUPPLY
Treet-O-Unit Proportioning Pump Controlled from Treet-O-Meter in line.

1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 SELECTIVE, UNIFORM REINFORCEMENT
4 MACHINE TOOL BEVELLED
5 TANGENTS
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE
Of course
— the fittings with the MOST advantage are the fittings that can be used to BEST advantage. Weld-ELLS have these eight features that are combined in no other welding fittings.
TAYLOR FORGE & PIPE WORKS
General Offices and Works:
P. O. Box 485, Chicago
New York Office: 50 Church St.
TAYLOR FORGE
WeldELLS

ments with respect to a high cetane number combined with a low cloud- and pour-point of the fuel. A fuel of this special type would be one with a minimum cetane number of 55-60 and a pour-point below —40° F. Such a combination is included in tentative and recommended specifications by the U. S. Navy and Army Air Corps, and a somewhat similar combination would be required for many Diesel aero-engines. Various possible treatments of fuels to secure these properties are discussed. The authors believe that the best procedure would be to start with a fuel of low pour-point, i.e., a non-waxy fuel, that can be solvent extracted to give a cetane number up to 40, and then to add 1-1.5 percent dope. The requirements of a suitable dope are outlined. In the paper the authors discuss the results obtained with acetone peroxide and ethyl nitrate as dopes, particularly with respect to their influence on the ignition delay of a fuel, on the further stages of the combustion process, on wear and incrustations in the engine, and on storage of the fuel. The data and results are presented in some detail in tabular and graphical form.

Copper Catalysis Accelerates Turbine-Oil Oxidation, H. FARMER, *Elec. World* **111** (1939) pp. 36-8, 103.

Specifications and test methods in general use do not recognize the catalytic action of copper in lubricating systems. The oxidation of turbine oil is greatly accelerated by heat and air in the presence of brass. The white metals do not materially affect the rate of oxidation. Four hundred ml. of oil were heated to 100° in a Pyrex-glass tube. Admiralty metal was immersed in the oil and then clean air bubbled through the oil. The oxidation rate with brass present was 10 times that with no metals present. The acceleration of oxidation caused by copper may be offset by introducing inhibitors into the oil. Water-soluble inhibitors are not effective.

The Efficient Burning of Fuel in High-Speed Oil Engines with Particular Reference to a Clean Exhaust, A. T. WILFORD, *Jour. Inst. Pet.* **25** (1939) pp. 649-56.

Measures taken by a large passenger-transport company to ensure efficient combustion of the fuel oil used by its fleet of oil-engined vehicles are discussed. The incentive for the work was two-fold; first, that of retaining the good will of the traveling public, and second, achieving economy in fuel consumption. Incomplete combustion is visibly evidenced by exhaust smoke, four types of which are recognized; a fifth is attributable to excessive consumption of lubricating oil. The prime necessity for efficient combustion is an engine of satisfactory design using a fuel of suitable ignition quality. This combination will not show the desired result, however, without proper attention to cleanliness of the fuel and to careful maintenance of the engine and accessories. The precautions taken in respect to the former, and the special methods employed for maintaining fuel-pumps and injectors in particular, are described in detail. A brief account is also given of endeavors to apply exhaust-gas-analysis methods to combustion control in oil engines.

Ozokerite and Ceresin, H. S. REDGROVE, *The Industrial Chemist,* Oct., 1939.

The commercial waxes are considered, including two waxes which are esters of fatty acids and high molecular weight monatomic alcohols. Paraffin waxes are considered. Among their drawbacks for some purposes are, their tendency to crumble, their crystalline structure, and their poor binding properties for oil Ozokerite is briefly discussed, including methods of purifying it into four market grades. At one time refined ozokerite was known as "ceresin." Present-day ceresins, however, are frequently no more than mixtures of paraffin and small amounts of refined ozokerite. The advantages of ozokerite in many compositions are emphasized.

Quantitative Determination of Aromatic Hydrocarbons by New Method, A. V. GROSSE AND R. C. WACKHER, *Ind. & Eng. Chem.,* Anal. Ed. **11** (1939) pp. 614-24.

A simple method for the rapid quantitative determination of aromatics in hydrocarbon mixtures boiling in the gasoline and naphtha range has been developed. The method is a physical one, and is based on the measurement of the specific dispersion of the sample. The dispersion is measured with an ordinary Abbe refractometer, or if more accurate results are required, by means of a Pulfrich refractometer. The authors' method is based on the fact, established by numerous investigators, that all saturated hydrocarbons, paraffins, or naphthenes, either mono- or polycyclic, independent of their molecular weights, have a

THEY'RE WRITING A CHAPTER IN REFINING HISTORY WITH

ACTIVATED ALUMINA

Pioneers in new "know-how" have been using a lot of Activated Alumina • They're using it to make gasolines dry. This eliminates the real cause of corrosion. It protects expensive equipment • They're using it to dry refinery gases. It prevents freeze-up of expansion valves • They're using it in the recovery of natural gasoline • They're using Activated Alumina as a catalyst and carrier in cracking and polymerization processes • ALUMINUM ORE CO. (*Sales Agent:* Aluminum Company of America, 1963 Gulf Bldg., Pittsburgh, Pa.)

ACTIVATED ALUMINA

AN "ALORCO" ALORCO PRODUCT

practically constant specific dispersion of 99 ± 1. The specific dispersions of the aromatics and olefins are higher. The dispersion of a substance is the numerical difference in the indices of refraction for two specified wave lengths. The specific dispersion is the dispersion divided by the density, both at the same temperature. The authors describe thir method in some detail, and give typical results of its application to synthetic solutions. Possible errors are discussed. A comparison between the specific dispersion method and the sulfuric acid absorption method is given. The data secured in the investigation are presented in 16 tables.

Evaluation of Certain Normal Alkylated Benzenes as Diesel Fuels, G. SHEN, C. E. WOOD, AND F. H. GARNER, *Jour. Inst. Pet.* **25** (1939) pp. 695-703.

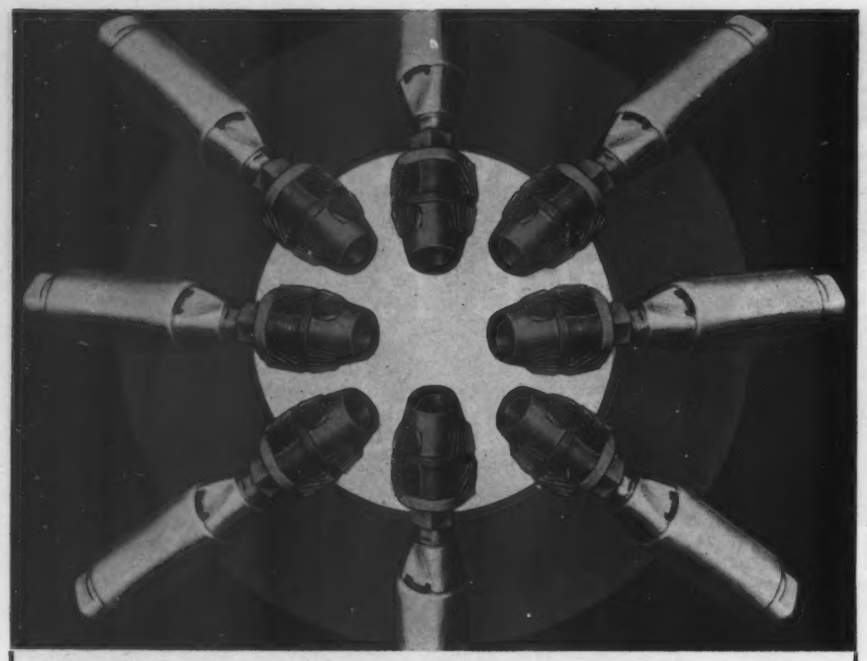
There has been no systematic investigation of the ignition quality of pure hydrocarbons distilling within the Diesel fuel range, although the octane numbers of a large number of hydrocarbons in the gasoline range have been determined. The hydrocarbons included in the investigation reported were paraffins, unsaturated aliphatics, aromatics, saturated naphthenes, with both five and six rings, and a number of unsaturated naphthenes and a few dienes. In the investigation reported it was decided to determine the cetane numbers of hydrocarbons derived from benzene by increasing the length of the paraffinic side-chain. Among these were amylbenzene, normal hexyl benzene, normal heptyl benzene, and normal nonyl benzene. All of these come within the distillation range of the lighter and middle fractions of Diesel oil. The preparation of the hydrocarbons is described. The cetane numbers were determined, using the C.F.R. Diesel fuel-testing engine. The cetane numbrs of the alkylated benzenes increased with increasing number of carbon atoms in the side-chains. The cetane number of amyl benzene is about 8, and that of n-nonylbenzene is 50. Data are given in some detail in tabular and graphical form.

The Application of Graphical and Statistical Methods of Hydrocarbon Analysis to Diesel Fuels, J. C. VLUGTER, H. I. WATERMAN, AND H. A. VAN WESTEN, *Jour. Inst. Pet.* **25** (1939) pp. 678-83.

The authors state that it does not appear to be desirable at the present time to derive a new formula for the correlation between chemical composition and the ignition delay of Diesel fuels, but this might be possible in the near future if more data on accurately analyzed Diesel fuels with known cetene values are available. If the influences of various percentages of different dopies are not taken into consideration, and attention is restricted, therefore, to the examination of hydrocarbon mixtures, then the work started by Kreulen is promising. This is confirmed by the authors' results. A more thorough investigation of a large number of Diesel fuels will be required in order to study the influence of chemical composition on the cetene or cetane value. In this respect it will be advisable to examine a large number of hydrogenated fuels, practically free from sulphur, nitrogen, and oxygen compounds, together with extracts and raffinates derived from these fuels, and also oils obtained by polymerizing olefines or olefine mixtures.

The Flow Properties of Asphalts and Their Measurement by the Penetro-Meter, C. MACK, *Jour. Soc. Chem. Ind.* **58** (1939) pp. 306-10.

The three main components of asphalts are asphaltenes, asphaltic resins, and oily constituents. It is generally agreed that asphalts are colloidal systems representing sols of asphaltenes in a mixture of asphaltic resins and oily components. At high temperatures asphalts are true solutions. At lower temperatures the asphaltenes associate to larger particles, the extent of which depends on the amount and type of asphaltenes, the amount of asphaltic resins, and the chemical structure of the oily components. The flow properties of the asphaltic bitumens and their influence on the penetration determination are discussed. An equation is given that presents depth of penetration as a function of time. It is shown that the constant of this equation expresses numerically the flow properties of asphaltic bitumens. The evaluation of viscous and plastic flow, thixotropy, and elasticity by means of this constant is demonstrated. If the consistencies of asphaltic bitumens are expressed in terms of seconds for a given penetration with the aid of the above mentioned equation, they refer to the same shearing stress, and the consistencies of bitumens of various flow properties are comparable.



5 to 10 TIMES MORE TORQUE—
30 to 75% MORE CLEANING POWER

From 5 to 10 times **more** torque is developed by the new Wilson E P (Extra Power) Series Air Motors—especially designed for refinery use—than by other motors of the same size. High torque means extra, more efficient power delivered to the cutter head at the tube walls. Power, where power is needed, is assured by the use of these new motors.

Recent tests have proven conclusively that although Wilson E P (Extra Power) Series Air Motors consume from 25% to 40% less air they actually deliver from 30% to 75% more power to the cutter head than ordinary motors and consequently reduce "down time," labor and air costs.

If you want efficient, economical and almost effortless tube cleaning use a Wilson E P (Extra Power) Series Motor.

Write for the name of our representative nearest to you or send for our new thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
55 Vandam Street **New York City**

The Packing With the *Twist*

The patented process of "Twisting" aluminum or lead foil around a resilient core is one of the secrets of success of Durametallic Flexible Metallic Packing. Often imitated—never duplicated.

Submit Your Sealing Problems to Us

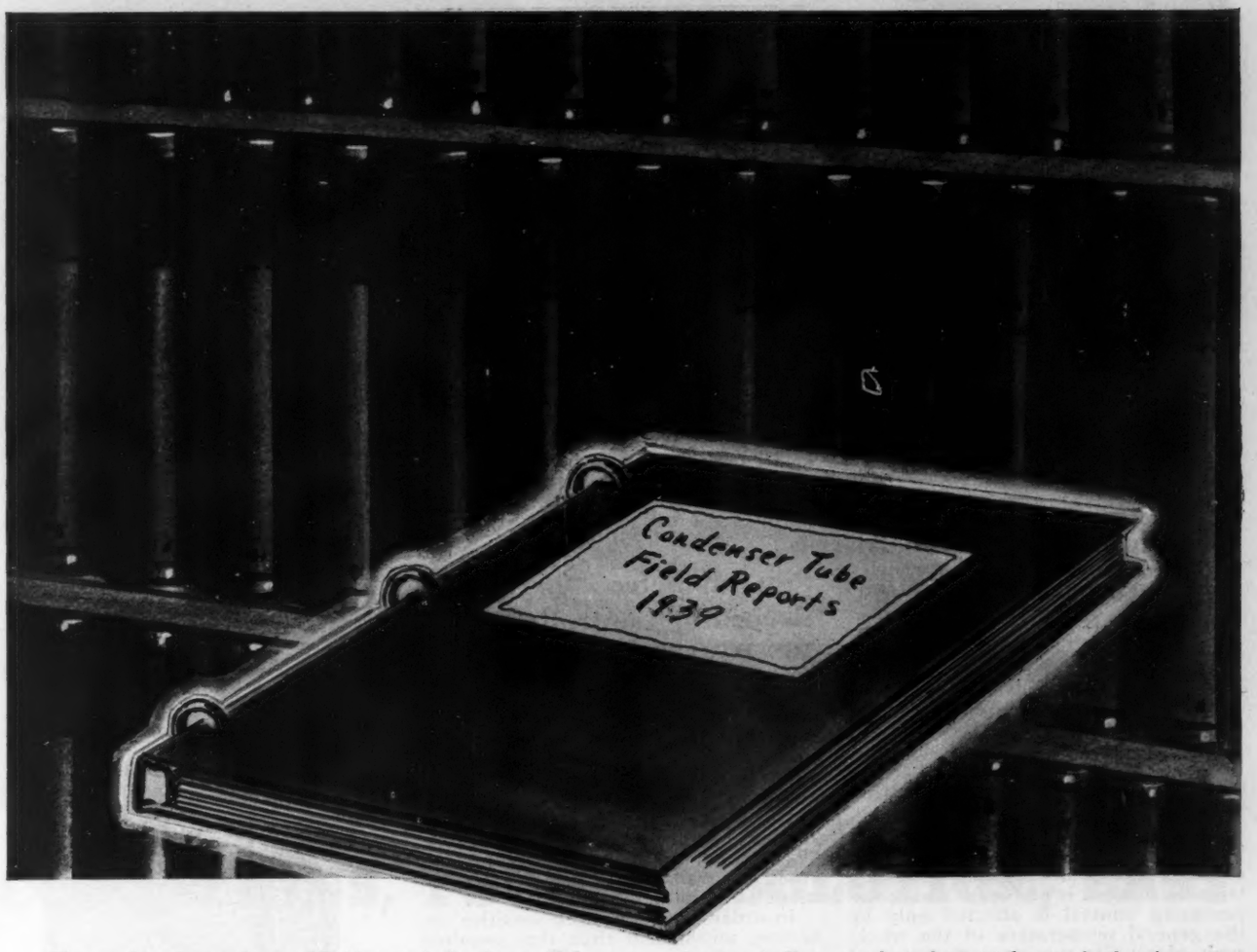
DURAMETALLIC CORPORATION
KALAMAZOO, MICHIGAN

The PERFECT SEAL

DURAMETALLIC
FLEXIBLE METALLIC PACKINGS
DURA SEAL THE MECHANICAL SEAL

NOTHING CAN REPLACE AN EXPERIENCE TABLE

WHEN CHOOSING A CONDENSER TUBE ALLOY



The combined experience of Bridgeport's Condenser Tube Engineers is an immensely valuable collection of knowledge available at all times to help solve your condenser or heat exchanger tube problems. Gathered over a period of years through actual work in the field, it is an experience table that includes nearly every conceivable operating condition, with the unique and widely different variables encountered in each one. More than likely, conditions very similar to yours are included.

Perhaps you and your company can profit by this experience. Frequently, a Bridgeport Condenser Engineer has been able to make recommendations which, through a change of alloy, saved on the *initial cost* of tubes for a customer. In other cases an alloy slightly higher in cost than the one replaced had a life span so much greater in proportion that a *saving in maintenance* was realized. Even recommendations for slight alterations in operating conditions, at nominal cost, have resulted in substantial increases in tube life—and lowered maintenance.

If you will consult with a Bridgeport Engineer before you reorder, it is entirely possible that *you* may obtain similar savings. Why not plan on this at once?

"Bridgeport" BRASS CO.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY • BRIDGEPORT, CONN. • ESTABLISHED 1865

WRITE FOR YOUR COPY

BRIDGEPORT BRASS COMPANY,
Condenser Tube Engineering Dept. A,
Bridgeport, Conn.

☐ I'd like to have a copy of the new revised "Condenser Tube Manual."

☐ I'd like to talk to one of your condenser engineers about my problem.

NAME.....

COMPANY..... TITLE.....

ADDRESS.....

CITY..... STATE.....

New Equipment for the Modern Plant

Stop Nuts
ELASTIC STOP NUT CORPORATION

Elastic Stop Nut Corporation, 1015 Newark Avenue, Elizabeth, New Jersey, has added nine new types to its line of stop nuts. Each embodies the self-locking element, a resilient non-metallic collar which is built into the head of the nut. This collar in resisting the entrance of the bolt or screw, forces the thread faces into a pressure contact which is maintained after the nut is tightened.

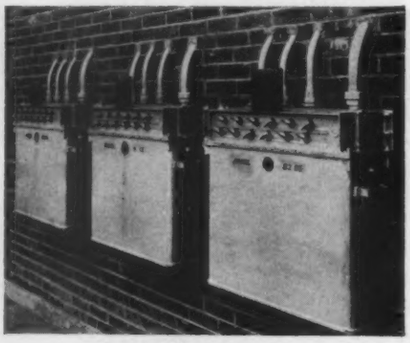
The new types are designated as thin hexagonal, spline, internal wrenching, countersunk and counterbored one-lug anchor, countersunk and counterbored two-lug anchor, countersunk corner anchor, bracket anchor, floating right angle anchor and floating basket anchor. With variations in sizes, thread systems and materials, 160 new standard items are offered.

Oil Immersed Panelboards
WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania, has designed new oil-immersed pannelboards for the protection of lighting circuits in locations exposed to corrosive elements and explosive atmospheres. A new thermal trip breaker has been developed to insure practically constant tripping regardless of temperature changes.

The new breaker has a compensating bimetal mounted outside the chamber of the breaker frame in which the main tripping bimetal is enclosed. This compensating bimetal is affected only by the general temperature of the whole tank of oil. Its motion is transmitted to the tripping bimetal through a link, thermally and electrically insulating the two members and passing through a small clearance opening in the breaker wall. The base of the tripping bimetal is pivoted, and while its deflection is dependent jointly upon the current and the general oil temperature, the pivoted base is moved just enough by the compensating bimetal to neutralize that part of the deflection of the tripping bimetal which is due to the general oil temperature. This makes the free end of the tripping bimetal responsive only to the load current.

The breaker is compensated within commercial limits permitting zero to 10 percent decrease in rating when the surrounding oil temperature is 140° F., and 0 to 10 percent increase in rating at oil temperature of 10° F. At 75° F., the deviation is zero and at intermediate temperatures the limits are proportionate.



Westinghouse Oil Immersed Panelboards

Potentiometer Recording Controller
THE FOXBORO COMPANY

The Foxboro Company, Foxboro, Massachusetts, has introduced a new series of potentiometer recording controllers, which incorporate three new features: improved detecting mechanism; new integral recording and control mechanism; and a new control system to provide maximum flexibility for use. Open-and-shut action or throttling action, with or without automatic reset, is available in the air-operated models of the new series.

In order to obtain more sensitive detecting mechanism than that required for recording, a single calibrated detecting cam is used. This cam will sense deflections of the galvanometer pointer of less than 0.0001 of an inch without lost motion. By positioning a friction roller, the cam positively determines the movement of the integral slide wire contact, recording and control actuating carriage.

Coordination of measuring, recording and controlling operations is achieved by an integral recording and control mechanism. The slide wire contact, recording pen and cam follower actuating the control cam are assembled as a unit on the same rigid carriage. By using an integral mechanism the need for linkages, belts or gears to transmit movement of one unit to the others is eliminated.

The control system is affixed directly to the shaft of the cylindrical control cam, which permits the compact self contained unit to require no linkages. The rotary motion of the control cam shaft makes for simplicity in providing for the type of control required by application conditions.

Foxboro Potentiometer

Stop Watch
M. DUCOMMUN COMPANY

M. Ducommun Company, 580 Fifth Avenue, New York, has improved its stop watches by adoption of non-breakable, rust- and corrosion-proof coil springs. Added to this is the independent hammer spring and the brake system. The improvements are used exclusively in Minerva time recorders.

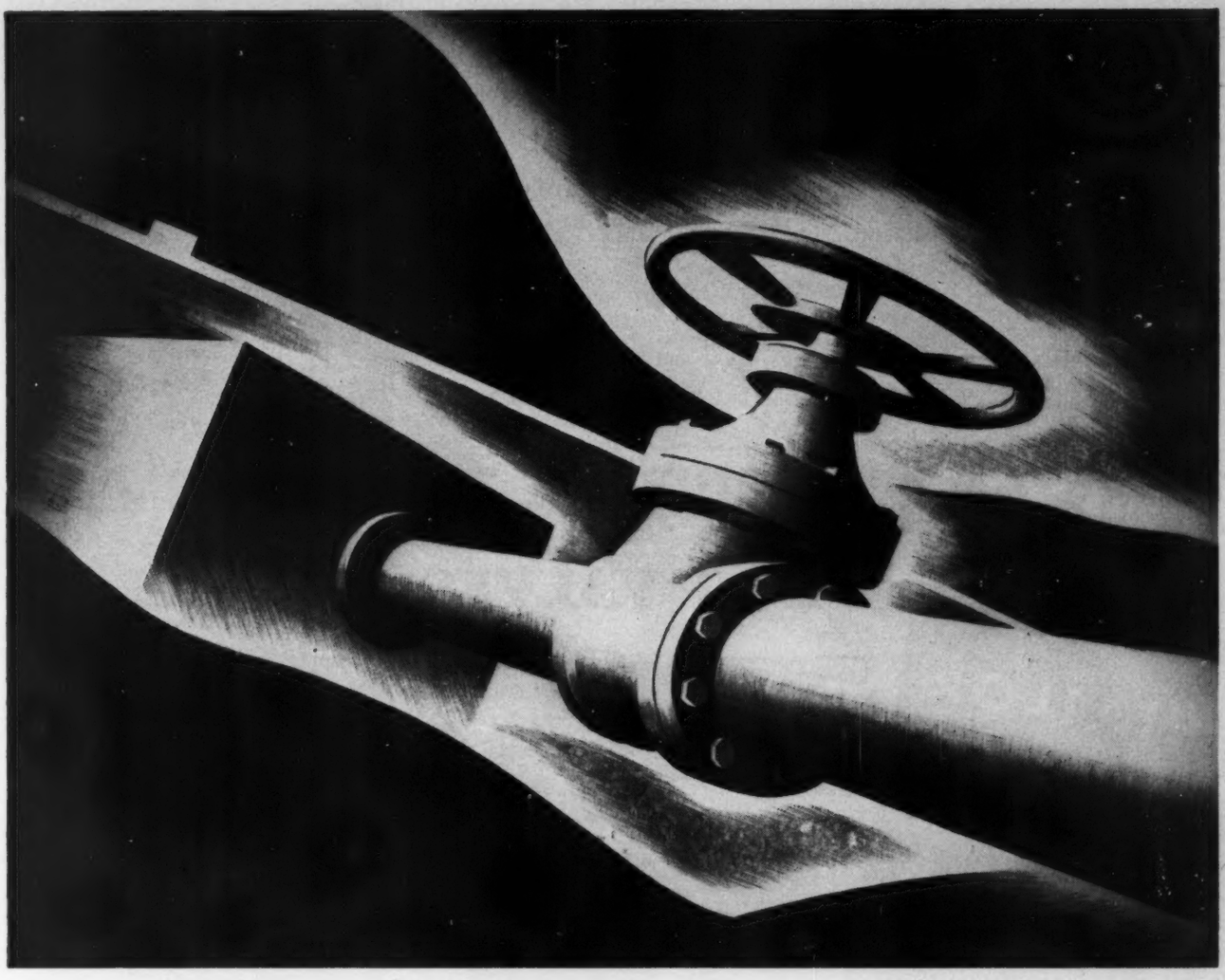
Ducommun Stop Watch

The coil springs eliminate friction and wear and keep equal elasticity. The independent hammer spring assures perfect fly-back to zero. The brake system, which controls starting and stopping, eliminates variations at zero.

Smithway Centrifugal Pump
SMITH METER COMPANY

Smith Meter Company, 5743 East Leneve Street, Los Angeles, has designed the "Smithway" Centrifugal Pump, a combination of a fully-inclosed, self-protected electric motor with pump in a single frame. The frame is so constructed that the liquid being handled is passed around a thin tubular shell of the motor to provide continuous cooling. The unit can be set for predetermined operating temperatures. The unit can be mounted in any position.

The pump will handle loads from 20 gallons per minute to 200 gallons per



CONDITIONS, TOUGH . . . SOLUTION, EASY

Crude oil pipe-line service imposes severe requirements on the valves, particularly those used at pumping stations, river crossings and other points to permit sectionalizing of the line. Working pressures are high. Continual expansion and contraction of long pipe lines put heavy loads on the valve flanges.

These severe conditions have been met with entire satisfaction by 10" valves made of Molybdenum cast iron (0.50% Mo). The iron is noteworthy for the uniformity of structure and properties when cast in heavy sections. It makes valves that test pressure tight at double the working pressure of 800 pounds. Tensile strength is 48,000 p.s.i.

You may well be able to apply this iron or one of the other Molybdenum irons to advantage. Our technical book, "Molybdenum in Cast Iron", giving full practical data, will be sent free on request to interested engineers and production executives.

PRODUCERS OF MOLYBDENUM BRIQUETTES, FERRO-MOLYBDENUM, AND CALCIUM MOLYBDATE

Climax Mo-lyb-den-um Company
500 Fifth Avenue · New York City

MOLY

"Smithway" Centrifugal Pump

minute. It will operate on temperatures to 200° F. and heads up to 250 feet.

The motor shaft is carried on two ball bearings, easily accessible and mounted in a single frame. Alignment is maintained as the impeller is mounted directly on the motor shaft.

Mixer Clamp

MIXING EQUIPMENT COMPANY

Mixing Equipment Company, Rochester, New York, has added a new hand clamp to its line of portable mixers, which permits attachment of the equipment to a vessel by turn of a hand wheel. The device is standard equipment on all portable models from 1-8-horsepower and larger. A complete kit of parts for adding this convenience to present models is also available.

The hand clamp retains all features of the ball and socket clamp and make attachment or detachment a matter of seconds. Chief feature of the clamp is the double wedge, which tightens the unit firmly and cannot work loose. Double bronze wedges, cadmium plated king pin and lock nut, parkerizes locking screw and aduminum wheel prevent the equipment from rusting or freezing. The wedges are fully adjustable for wear.

Mixer Clamp

HOMESTEAD

PLUG VALVES

"TAILOR MADE" FOR REFINERY USE

Homestead Lever-Seald Plug Valve. Cannot stick. No lubrication or upkeep required.

Homestead "Lever-Seald" and "Cam-Seald" Plug Valves are *specifically designed* to meet and master the full range of temperature, pressure and corrosive service conditions of the modern Refinery. Their straight-thru flow, protected seating surfaces, positive sealing, and quick operation without lubrication, even under the heat and pressure conditions of Catalytic Refining, assure unusually long life with lowest maintenance. Rugged construction, the *right* metals for each service, precision manufacturing methods, individual inspection and test, and the benefits of 46 years of *valve engineering* go into the making of every Homestead Valve. It will pay you to specify "Homesteads" on your next valve order.

Homestead Valve Mfg. Company
P. O. BOX 16 CORAOPOLIS, PA.

HOMESTEAD VALVES

Send for Valve Reference Book No. 38 for complete information.

Synthetic Wax

GYLCO PRODUCTS COMPANY, INC.

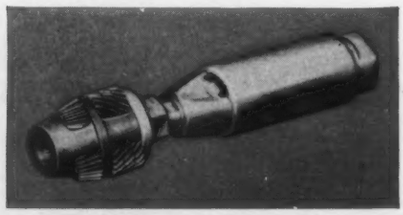
Glyco Products Company, Inc., 148 Lafayette Street, New York, has a new high melting point synthetic wax, Acrwax C, which is made from domestic raw materials. It has a melting point of 133 C. and is not brittle. It is insoluble in water and soluble hot in mineral spirits, turpentine, naphtha and similar hydrocarbon solvents. Solutions in turpentine, naphtha and toluol produce stable gel on cooling. It blends with paraffin, carnauba wax and candelilla wax.

Tube Cleaners

THOMAS C. WILSON, INC.

Thomas C. Wilson, Inc., 55 Vandam Street, New York, has developed a series of tube cleaning motors and cutter heads for refinery use and adapted to removing either coke or gummy deposits.

The new Wilson EP Series air motors are six-bladed, two-cylinder motors, in which power is increased because of the six overlapping power impulses per revolution. The method of introducing air into the cylinders as-



Wilson Tube Cleaner

CONDENSATE DRAINAGE FACTS

HOW TO SELECT DRAINAGE EQUIPMENT

To insure continued trouble-free operation, it is important to analyze carefully the conditions for which condensate drainage equipment will be required:

1. When inlet pressures vary materially, the reduced rating of the drainage equipment at the lower pressure should be considered, to avoid possible trouble from failure to discharge the desired amount of condensate.
2. Unless drainage conditions are known to be uniform, care must be taken to install drainage equipment with capacity to handle instantaneous peaks.
3. Temperature of condensate in relation to its pressure influences the discharge capacity of a drainage unit. The capacity is greatest when discharging cold water, but as the condensate temperature approaches that of steam at the given pressure, the capacity becomes correspondingly less.

Cochrane Multiport Drainers are designed for continuously removing large quantities of condensate under vacuum or positive pressures.

For recommendations and data consult the Cochrane representative or write directly to Cochrane Corporation for Publication 2925.

Cochrane Multiport Drainer

COCHRANE CORP., 3115 N. 17th St., Philadelphia, Pa.

COCHRANE

VALVES • TRAPS • SEPARATORS • SPECIALTIES

PALMETTO
for steam, air, hot fluids
PALCO
for water
PELRO
for solvents, oils
CUTNO
for alkalies
GLASO
for acids

"I don't care what Packing is made of!"

"My job is to keep machines working. So I pack steam rods, pumps and valve stems with the best packing I can get. That's Greene, Tweed. It stands up longer than any other packing that I have ever used."

TRY IT AT OUR EXPENSE

Send for a working sample. Try it against any other packing. If Greene, Tweed does not outlast the other packing we don't want your business.

GREENE, TWEED
SELF-LUBRICATING
PACKINGS

GREENE, TWEED & COMPANY, 101 Park Ave. New York, N.Y.

Greater Efficiency with

MT. VERNON EXTRA

Precision Filter Fabrics

• The quality of any filtering media is no better than its poorest filtering area. That is why the consistent uniformity of MT. VERNON EXTRA filter fabrics is appreciated by those in charge of your filtering operation. There are no thin areas, no superfluously heavy areas in MT. VERNON EXTRA fabrics. They are woven to rigid standards of tolerance in a modern mill whose whole production is guided by more than fifty years' experience. Specify MT. VERNON EXTRA precision filter fabrics.

MT. VERNON WOODBERRY MILLS, INC.

TURNER HALSEY COMPANY
Selling Agents
40 WORTH STREET ★ NEW YORK, N. Y.
CHICAGO • NEW ORLEANS • SAN FRANCISCO • BOSTON • BALTIMORE • LOS ANGELES

sures positive starting and eliminates sticking. High torque is maintained due to the blades being held in close contact with cylinder walls by incoming air. Permanent seal between the intake and exhaust areas of opposing cylinders maintains efficiency and reduces internal air losses. Cool operation comes from use of generous exhaust air passages which reduce back pressure.

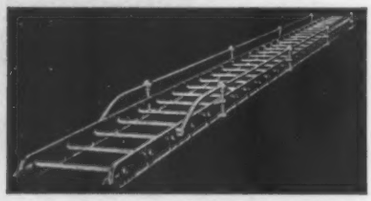
A complete set of cutter heads is provided as matched units with motors of different sizes.

Aluminum Ladder

ALUMINUM LADDER COMPANY

Aluminum Ladder Company, Tarentum, Pennsylvania, has a new ladder, Type 800, equipped with hand rails on both sides and either steel or aluminum spikes on the bottom. The fact that aluminum does not spark makes the ladder safe for work around oil tanks and other places where inflammable materials are stored.

The ladder can be supplied in lengths

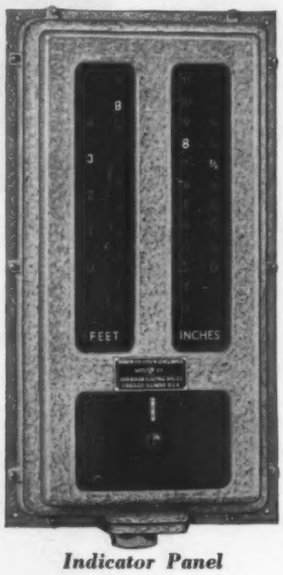


up to 36 feet and in various widths. Rungs are corrugated. This ladder is the latest model in a line of single wall ladders, sectional ladders and platform ladders.

Remote Liquid Level Gauge

GUARDIAN ELECTRIC MANUFACTURING COMPANY

Guardian Electric Manufacturing Company, 1621 West Walnut Street, Chicago, has an electric liquid-level gauge for recording the amount of oil or other liquids in steel storage. It consists of a tank head gauging unit for each tank and an indicator panel, which will serve for all tanks in a battery. The mechanism is not affected by temperature, weather, variation in specific gravity or distance between tanks and control office. Failure of current does not effect accuracy since power is used only when tanks are being gauged.



Indicator Panel

The tank head gauging unit consists of a mechanism sealed in oil. The head is of cast aluminum and the gears are bronze. The float and bridle assembly is designed to pass through standard manholes. The float displaces 1-16 inch of liquid and operates a control mechanism on as little as 4 ounces pull. By gland sealing the tape exit and closely fitting the aluminum pipe at the tank head housing, gauge may be used on all types of sealed tanks without loss of vapor.

The indicator panel can be connected to 24 tanks on the standard model or a larger

Gauging Unit

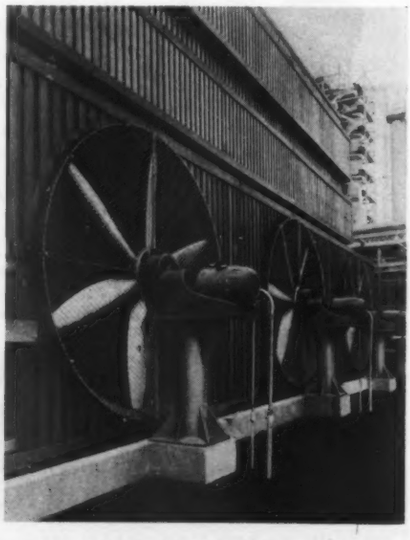
number can be proved as desired. Each tank is gauged by turning a dial to the number of the tank. Then by pushing a button the exact depth shows in lights on the indicator panel. Feet are shown in red numerals and inches and fractions in green. The panel is gasket sealed and vapor proof.

Cooling Tower

FLUOR CORPORATION

Flour Corporation, Ltd., 909 East 59th Street, Los Angeles, has forced-draft cooling tower with which aluminum alloy fans with adjustable pitch are used. The fans are pedestal mounted and motor driven through special gear reduction units.

Exterior walls of the tower are of the



Fluor Cooling Tower

VIGILANT
Liquid-Level
REGULATOR

LIQUID LEVEL
and
Flow In or Out
under positive
Remote Control

In the operation of Stills, Vaporizers, Bubble Towers, and Dephlegmators, a continuous inlet or outlet flow and a constant level of condensates can be definitely secured by installing a differential-type Vigilant Liquid Level Regulator on the side of the tank, and the control valve on the inlet or outlet line as required. Control works on compressed air, steam, water or gas.

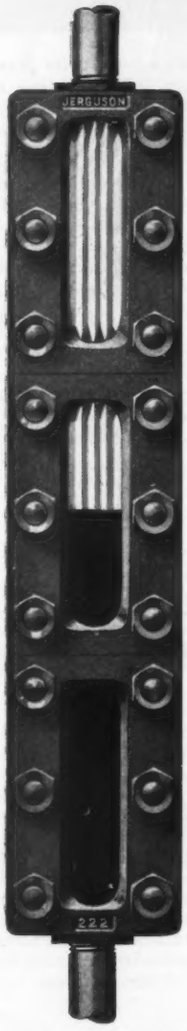
New Catalog on request.

The **CHAPLIN-FULTON MFG. CO.**

28-40 PENN AVE. CF PITTSBURGH, PA.

JERGUSON

BE SURE that the name JERGUSON is on your Gages



Jerguson Reflex and Transparent (thru vision) Gages have been noted for over 30 years for accuracy and dependability.

Reflex Gages indicate the liquid level, no matter what the color of the liquid. Ideal for tanks, towers, stills, etc., because the

Empty space shows

WHITE

Liquid level appears

BLACK

JERGUSON Transparent (thru vision) Gages for showing color and density of liquids, are also noted for their accuracy and dependence.

There's a JERGUSON GAGE for your plant

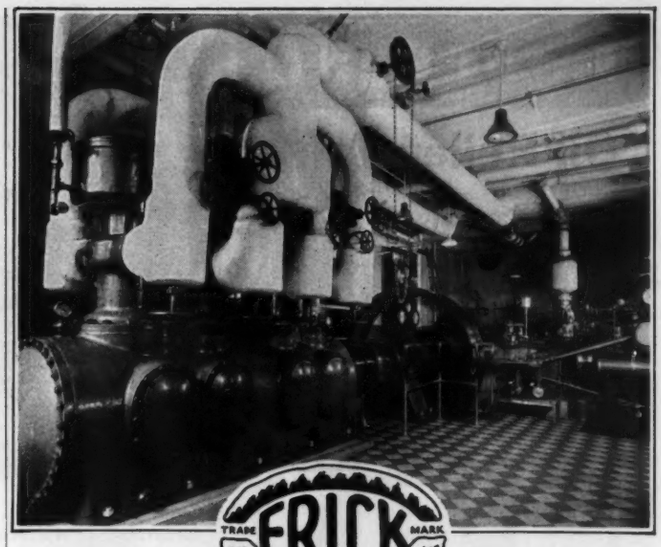
Jerguson Gages are best by every real test

Catalog on Request

JERGUSON GAGE & VALVE CO.

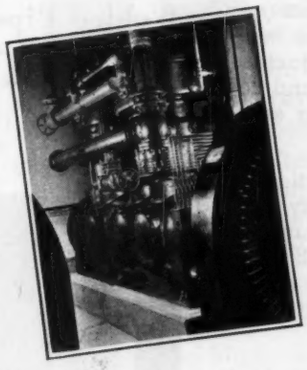
87 FELLSWAY

SOMERVILLE MASSACHUSETTS



Refrigeration

Comes in big units, these days, as if reviving the huge Frick machines of forty or fifty years ago.



Modern Frick four-cylinder compressors are built in six large sizes, with cylinders 10 in. by 10 in., 11 by 10, 12 by 12, 13 by 12, 15 by 10, and 17¾ by 12. The two largest are adapted particularly to ammonia booster service on low temperature work, as well as for use with Freon-12 on air conditioning work.

Typical installations of these four-cylinder Frick compressors are illustrated; one uses steam engine drive, the other synchronous motors. The machine above has double suction connections. Both have capacity control valves, permitting regulation of the load in four steps.

Get full details on the latest Frick Refrigerating, Ice-making and Air Conditioning Equipment now. Literature and estimates cheerfully supplied on request. Write

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

Lonergan

Oil Relief Valve

Keeps a Constant Lookout for Excess Pressure Attacks

INSURES SAFETY

Like all members of the Lonergan family of power plant safety appliances, the model "WTN" is thoroughly dependable—time-tested and backed by the Lonergan reputation for fair dealing the world over. This valve is manufactured for high pressure service, and conforms to the most exacting safety requirements.

Insures safety and satisfaction because it is backed by sixty-seven years of engineering and manufacturing experience as well as a thorough knowledge of the operating conditions for which it is designed.

Made in sizes ranging from 1" to 6". Can be manufactured from any metals suitable for its intended service and in accordance with specifications for gases or liquids of any nature.

For prompt service in gauges, relief valves and other power plant specialties, order with confidence from your local Lonergan distributor or write direct.

J. E. LONERGAN CO.
SECOND & RACE STS., PHILADELPHIA, PA.
300 Specialties for Power Plants
Standard Since 1872

Lonergan
GAUGES · VALVES · SPECIALTIES

Ohio Steel Foundry Company, Springfield, Ohio, has added a new shop to its plant facilities for the manufacture of return bends and tube supports. The building is an additional unit in the refinery equipment division.

new aerator type outer shell construction which provides ventilation for outside walls. The tower is prefabricated of California redwood and erected with brass bolts and hardware.

The illustration shows fan installation in a refining plant. The unit is 48 feet long, 40 feet deep and 28 feet high. It has 6 cells, each measuring 20 feet by 15 feet and is rated to cool 5000 gallons of water per minute.

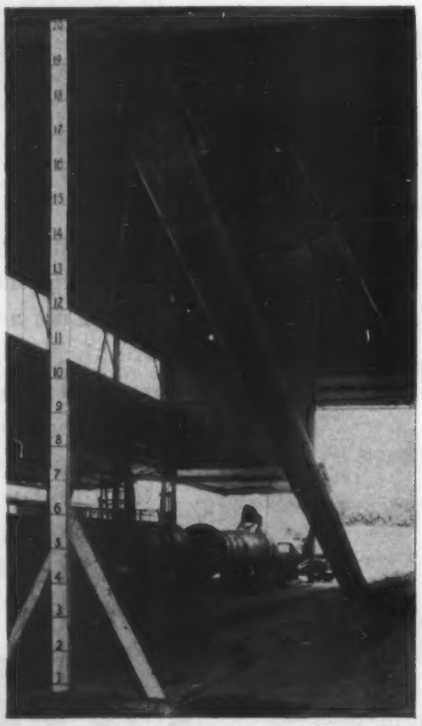
Welded Pipe

WYATT METAL & BOILER WORKS

Wyatt Metal & Boiler Works, Houston and Dallas, has been given approval of the Underwriters' Laboratories for the manufacture of large diameter pipe by welding for use in underground water service and for fire service systems.

The pipe is rolled from steel plates to any desired size and welded inside and out. Facilities have been installed for hot coating both inside and outside surfaces and the Houston plant is now producing pipe 24 inches in diameter. Ends can be beveled for welding or prepared for mechanical couplings as specified.

Method of finishing gives the pipe corrosion resistance for brine lines and salt water disposal systems around refining plants. It can be used for steam lines or for water systems, especially where large diameters are desired.



Testing welded pipe to determine yield of given length with the pipe filled with water and the ends plugged.

Paint

B. F. GOODRICH COMPANY

B. F. Goodrich Company, Akron, Ohio, has a new Karoseal paint, No. 495 Korolac, a name adopted to cover solutions of the plasticized poly-vinyl chloride whose basic materials are coke, limestone and salt.

The new paint gives a semi-glossy black finish and is for use where corrosive conditions are present. A Korolac primer is used to form a bond between metal and itself. The paint will withstand acids, alkalies and salts in concentrations commonly experienced in industry up to temperatures of 150°F. It can be applied to alloys. Ordinary atmospheric conditions do not affect the paint, which is moisture resistant. The dried film is hard and resistant to abrasion yet elastic to conform to contraction and expansion of the support.

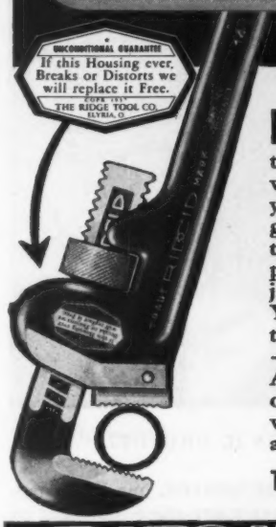
Minerva* STOP WATCH *offers unmatched* SERVICE *thru Patented COIL SPRING

Since 1858

- **The only Stop Watch equipped with coil spring.**
- **Guaranteed against breakage, wear, flaws.**
- **Stop Watches for all purposes. FREE TRIAL.**
- **Nationally-reputed repair service. Write for catalog.**

M. DUCOMMUN CO.
580 FIFTH AVENUE NEW YORK

Yep . . . you sure can cut your wrench expense with this Guaranteed RIDGID



MILLIONS of users have learned how that housing guarantee adds to the life of a wrench, keeps it at work, stops time-out for repairs, cuts your investment in spare parts. You get the same expense-saving with this modern all-alloy wrench, with replaceable safe chrome-molybdenum jaws that grip and let-go instantly. You actually enjoy the adjusting nut that spins easily in all sizes, 6" to 60" —and the comfort-grip I-beam handle. And mind you, it costs no more than other top grade wrenches it far outworks. Save money—buy RIDGIDs at your Supply House . . . *today!*

THE RIDGE TOOL CO. • ELYRIA, OHIO

RIDGID PIPE TOOLS

ARC WELDING IN DESIGN, MANUFACTURE AND CONSTRUCTION

This book is a compilation of outstanding contributions in the recent $200,000 Award Program conducted by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. Altogether the book contains 109 award papers.

This book provides scientific and technical schools, colleges and universities, engineering bodies and libraries, as well as industrial executives and officials, a tremendous volume of data on welding. The book will also be of incalculable value to designers, engineers, architects, production officials and others desirous of obtaining the benefits attributed to arc welded construction. All photographs and drawings essential to a clear and adequate presentation of each subject are included. Each study includes designs, calculations, procedures and other pertinent information showing how the advantages attributed to arc welded construction are obtained.

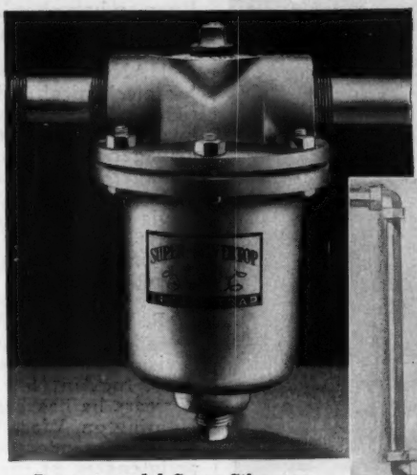
Size: 6"x9". Simulated leather cover, gold embossed
Price: $1.50—U. S. . . . $2.00—Foreign Countries

Send orders to

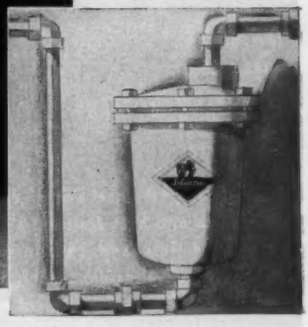
THE GULF PUBLISHING COMPANY
P. O. Box 2811 **HOUSTON, TEXAS**

• SIMPLIFIED PIPING

the result of 53 YEARS' PROGRESS



1931 model with puzzle piping



Present model Super-Silvertop with simplified piping

Super-Silvertop installed as an elbow

• Yes, the 1931 model Anderson steam trap was a good trap—but 53 years of research and experience pointed the way to progress. The present model Anderson Super-Silvertop brings simplified piping. It makes our old style trap with its puzzle-piping not only wasteful but obsolete.

This modern Super-Silvertop trap simplifies steam trap piping with a saving of fittings and labor. In fact, users report a saving of as many as 13 fittings and from 40 to 60 minutes of time on every trap installed. It has the further advantage of 102% increase in capacity over the previous model Anderson trap. Users not only have a choice of elbow or straight-in-line connection but a trap that is easy to inspect without disturbing pipe connections. In addition, guided bucket insures longer bucket life, and bored passages of liberal area prevent clogging with scale.

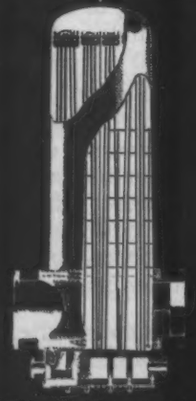
Our engineering department is constantly working to improve the Super-Silvertop line even more. Further improvements are sure to come, for the Anderson Company intends to lead the field in *more* progress in steam traps in the years ahead. Have all the facts at your fingertips . . . write today for complete information.

THE V. D. ANDERSON COMPANY
1942 WEST 96th STREET • CLEVELAND, OHIO

VICTOR
Heat-Treated alloy steel
STUDS
for flanged fittings and valves

Manufacturers of
Special
BOLTS
STUDS
NUTS
of high strength, heat-treated alloy steels, corrosion and heat resistant alloys, non-ferrous metals and carbon steels for refineries, natural gasoline plants and manufacturers of refinery and oil field equipment.
Write for complete catalog!
VICTOR PRODUCTS CORP.
2641 Belmont Ave. • Chicago, Ill.

LEACH
FRACTO
CONDENSERS
for High Pressure and Temperature.



Also Heat Exchangers for Vacuum and Atmospheric Service.
Fracto Control
Patented in the United States and Foreign Countries.
C. H. LEACH CO., Inc.
117 Liberty Street, New York, N. Y.

BUSINESS NOTES

FRANK LUDLAM, assistant secretary and assistant treasurer, International Nickel Company, Inc., died December 8 in New York. He had been with the organization since 1903.

JOSEPH T. RYERSON & SON, Inc., Chicago, have become distributors of McKay certified stainless steel electrodes. The product is stocked at all Ryerson branches. A certificate of weld-deposit analysis each package.

CHANGES in the sales staff of the mechanical division of B. F. Goodrich Company have been made as follows: I. N. Kimsey has been named manager and R. A. Charlton, assistant manager of the Akron sales division; J. S. Gulledge is manager of the St. Louis district and A. M. Fiala is product sales manager of the Air-Cell division, the company's new latex cushioning material.

DR. WILLIAM A. MUDGE has been added to the staff of the technical devision of International Nickel Company, Inc., in New York. For the past 17 years he has been at the company's Huntington, West Virginia, rolling mill as superintendent of research and superintendent of the refinery as well as works metallurgist.

HAROLD W. STODDART has been named manager of the turbine well pump division of Worthington Pump and Machinery Corporation, Harrison, New Jersey. He has been with the organization since graduation from Iowa State College in 1919 and has been allied with its turbine well pump division since 1921.

PEREZ & HELTON, 1701 Commerce Street, Houston, have been appointed agents for Swift Lubricator Company for Texas and Louisiana.

THE business of Worthington Machinery Corporation, 424 North Boulder, Tulsa, Oklahoma, was taken over December 1 by Worthington Pump & Machinery Corporation as its district office at that address. The district will be under the management of J. O. Lewis. The former corporation will remain in existence for the settlement of current business and collection of outstanding accounts.

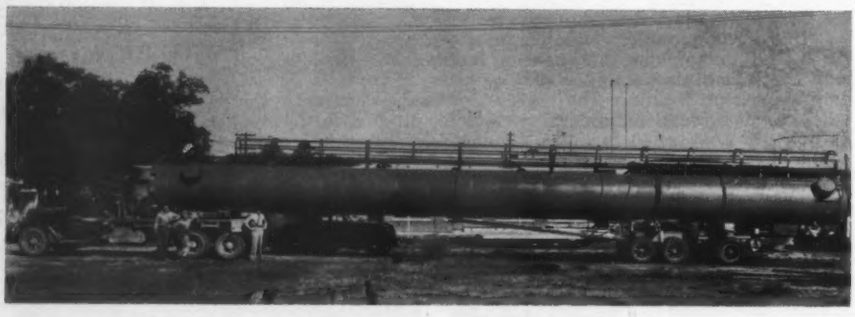
LOUIS H. BRENDEL

LOUIS H. BRENDEL has been promoted to assistant sales manager of Manning, Maxwell & Moore, Inc., Bridgeport, Connecticut. He has been assistant sales manager of the Hancock valve division of the company and in his new duties will supervise sales promotion and jobber relations of the several divisions of the concern.

HARRY W. SCHUETZ has been appointed assistant to the president and general manager of Pittsburg Screw and Bolt Corporation. He has been with the company for 15 years.

DIRECTORS of the Natural Gasoline Supply Men's Association met in Tulsa December 28 and heard the report of the treasurer, which showed the organization in good financial condition and ready for its part for the meeting of the Natural Gasoline Association of America in Tulsa, May 15 to 17.

Additional memberships were considered and members were urged to give possible names, after several had been offered.



Ready for truck delivery from Shreveport to Kilgore, Texas, is this absorber, fabricated by the J. B. Beaird Corporation for Hercules Gas Company. The vessel was designed by Hudson Engineering Company, Houston. It is 5 feet inside diameter, 73 feet long, made of 11/16-inch fire box quality steel plate.